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VIKING [illegible] INC

SYSTRON DONNER

OPERATION AND SERVICE MANUAL

VIKING LABORATORIES INC

MODEL 2311 VARIABLE PERSISTENCE DISPLAY UNIT

AND

MODEL 2312 STANDARD PERSISTENCE DISPLAY UNIT

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SYSTRON DONNER CORPORATION
ONE SYSTRON DRIVE
CONCORD, CALIFORNIA 94518 USA

STANDARD PERSISTENCE
DISPLAY UNIT
VARIABLE PERSISTENCE
DISPLAY UNIT
MODEL 2311 AND 2312

MICROWAVE DIVISION
SYSTRON DONNER CORPORATION
INSTRUMENT GROUP

PRINTED January 4, 1977
MANUAL P/N 110129

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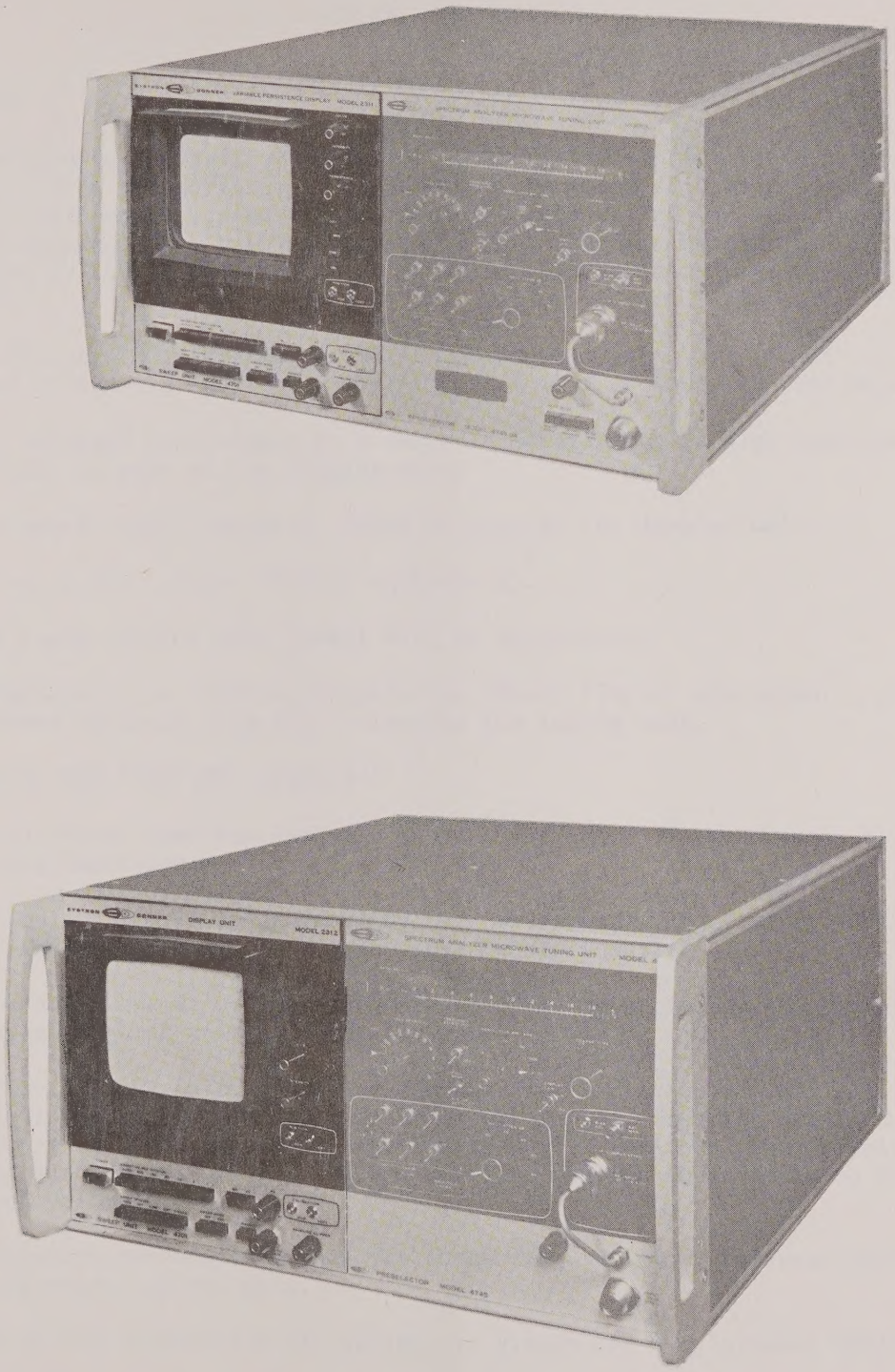

Figure 1-1. Model 2311 and Model 2312 Display Units

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SECTION I
GENERAL INFORMATION

1-1. SCOPE

This manual provides general information, installation instructions, operation instructions, circuit descriptions, performance check and adjustment procedures, maintenance information, parts lists, and circuit diagrams for the Model 2311 Variable Persistence Display Unit and the Model 2312 Standard Persistence Display Unit, manufactured by the Systron-Donner Corporation, 14844 Oxnard Street, Van Nuys, California 91411.

The Model 2311 and 2312 display units are shown in figure 1-1. Either of these units may be used to house a Spectrum Analyzer System that includes the following:

1. A standard persistence or a variable persistence display subassembly, which is part of the display unit.

2. A power supply assembly, which is part of the display unit.

3. Tuning Unit (Model 4809 or equivalent).

4. A Sweep Control Unit (Model 4701 or equivalent).

5. Optionally, a Tracking Preselector (Model 4745 or equivalent), or other optional accessory bolted to the tuning unit.

1-2. PURPOSE AND FUNCTION (table 1-1)

In a Systron-Donner Spectrum Analyzer System, the Model 2311 or Model 2312 performs the following functions:

1. Displays the video produced by the tuning unit. Horizontal deflection and blanking is controlled by the sweep control unit.

2. Develops the dc voltages required for the operation of the tuning unit, the sweep control unit, and the accessory module.

3. Provides the interconnecting cabling from the sweep control unit to the tuning unit and the optional accessory module, from the dc power supply (part of display unit) to the tuning unit, the sweep control unit, and the optional accessory module, and from the display subassembly to the sweep control unit.

4. Provides connection points for connecting auxiliary external equipment to the sweep control unit.

5. Provides circulation of cooling air within the display unit housing.

Table 1-1 lists the performance specifications for the Model 2311 Variable Persistence Display Unit and the Model 2312 Standard Persistence Display Unit.

TABLE 1-1. SPECIFICATIONS

ITEM	SPECIFICATION
Dimensions	8-3/4 inches high by 16-3/4 inches wide by 9-1/2 inches deep.
Weight	30 pounds without plug-in or bolt-on units.
Input Power Requirements	115/230 Vac (±10%), single phase, 50 to 70 Hz. 100 watts with typical plug-in and bolt-on units installed.
DC Supply Voltages	+70V (regulated), ±24V, and +10V to plug-ins and bolt-ons.
Display Subassembly: (Standard or Variable Persistence)	
Display	Rectangular, flat-face CRT, P-31 aluminized Phosphor.
	8 by 10 cm with vertical and horizontal lines for 1 cm divisions. The horizontal and vertical center lines are divided into 5 sub-divisions per major division. The left edge is marked from 1 to 8 for LINEAR operation, and the right edge is marked from 0 to 70 dB for LOG operation. The LOG reference level is marked at the top of the screen.
X and Y inputs:	
Bandwidth	DC to 1 MHz (3 dB down at 1 MHz).
Phase Shift	Less than 1 degree to 500 KHz.
Settling Time	Signal settles to within one spot diameter of final value within less than 1 usec (Model 2311) or 1.2 usec (Model 2312) for any on-screen movement.
Input	Differential between center conductor and shield; shield may be grounded with internal connection.
Common Mode Rejection Ratio	40 dB to 10 KHz for differential input of 3V maximum between outer and inner coaxial input leads.
Maximum Input	±50V (dc plus peak ac).

TABLE 1-1. SPECIFICATIONS (Continued)

ITEM	SPECIFICATION
Input RC	Single-Ended: 100K ohms shunted by approximately 80 pF to ground. Differential: 200K ohms shunted by approximately 80 pF to ground.
Deflection Factor	Vertical: 0 to +1.0 volt ramp produces 8 division deflection. Internally adjustable from 0.09V/div to 0.14V/div. Horizontal: -0.5 to +0.5 volt ramp produces 10 division deflection. Internally adjustable from 0.09V/div to 0.14V/div.
Z (Blanking) Input:	
Bandwidth	DC to 5 MHz; risetime approximately 70 ns.
Input	-1V blanks spot of any intensity; +1V turns beam full on.
Maximum Input	+10V (dc plus peak ac).
Input RC	Single-Ended: 10K ohms shunted by approximately 60 pF to ground. Differential: 20K ohms shunted by approximately 60 pF to ground.
Display Linearity (Horizontal and Vertical)	Less than 5% difference between any two divisions.
Writing Speed (Conventional Mode)	1000 div/msec measured photographically, with ASA-3000 film (typical) single-shot method.
Brightness	Greater than 100 feet lamberts.
Variable Persistence Display Subassembly (Model 2311 Only)	
Writing Rate in WRITE mode	200 div/msec measured photographically with ASA-3000 film (typical) single-shot method.

TABLE 1-1. SPECIFICATIONS (Continued)

ITEM	SPECIFICATION
Persistence	Variable from 0.2 seconds to 1 minute in WRITE mode.
Storage Time	At least 15 minutes.
Erase Time	Less than 1 second.
Dot Writing Time	Less than 4 usec.

1-3. PHYSICAL DESCRIPTION

The display subassembly is mounted on the left side of the display unit. The space below the display subassembly is reserved for the sweep control unit. The rear section of the compartment on the right side of the display unit contains the power transformer and the power supply assembly. The tuning unit and accessory module are installed on the right side.

The rear of the unit contains the power connector and associated fuse and voltage selector switch, and the connections for external auxiliary equipment. A cooling fan provides the circulation of cooling air. The housing for the fan on the right side (as viewed from the rear) must be opened to gain access to an internal voltage selector switch and fuse, and the connectors and maintenance controls for the display subassembly. This fan housing is secured by two quick-release fasteners. When the housing is opened, an interlock switch disables the fan.

1-4. ELECTRICAL INTERCONNECTIONS (figure 1-2)

As shown in figure 1-2, the display unit contains a power supply wiring harness and a main wiring harness for interconnecting the various elements of the spectrum analyzer system.

CAUTION

Refer to paragraph 2-4 for installation of proper fuses and setting of switches for 115V or 230V operation.

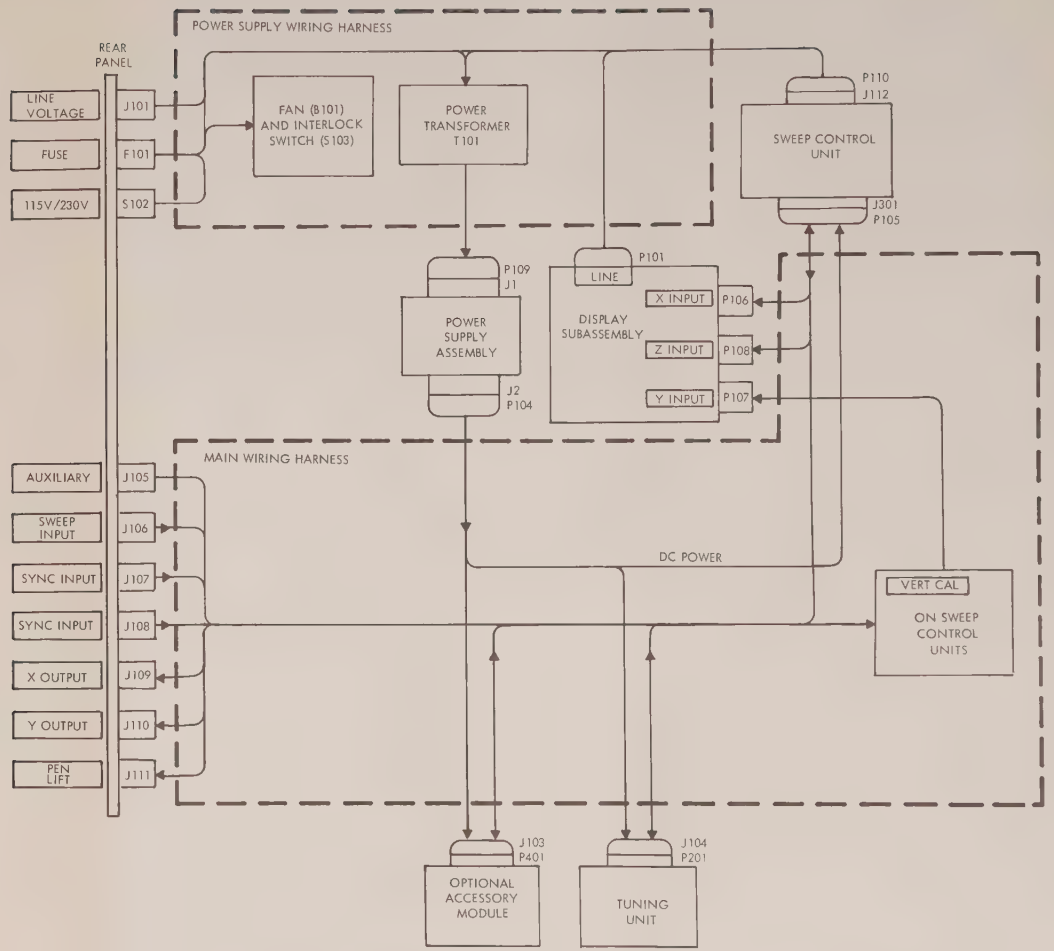


Figure 1-2. Electrical Interconnections

SECTION II

INSTALLATION

2-1. GENERAL

The display unit serves as the mainframe for a spectrum analyzer system. It is assumed that all components of the spectrum analyzer system are already installed in the display unit. Installation, therefore, consists of locating the instrument in an acceptable environment, and making the required external power connections.

2-2. ENVIRONMENTAL CONSIDERATIONS

The spectrum analyzer is a rugged instrument designed for normal field or laboratory usage. Avoid subjecting the case to prolonged exposure to direct sunlight or other strong source of thermal radiation. Do not place the case on a hot surface or on a surface subjected to strong vibrations. Provide clearance at the rear of the unit.

2-3. MOUNTING (figure 2-1)

The display unit contains four feet on the bottom surface to permit mounting on any flat surface. Figure 2-1 shows the outline dimensions of the unit.

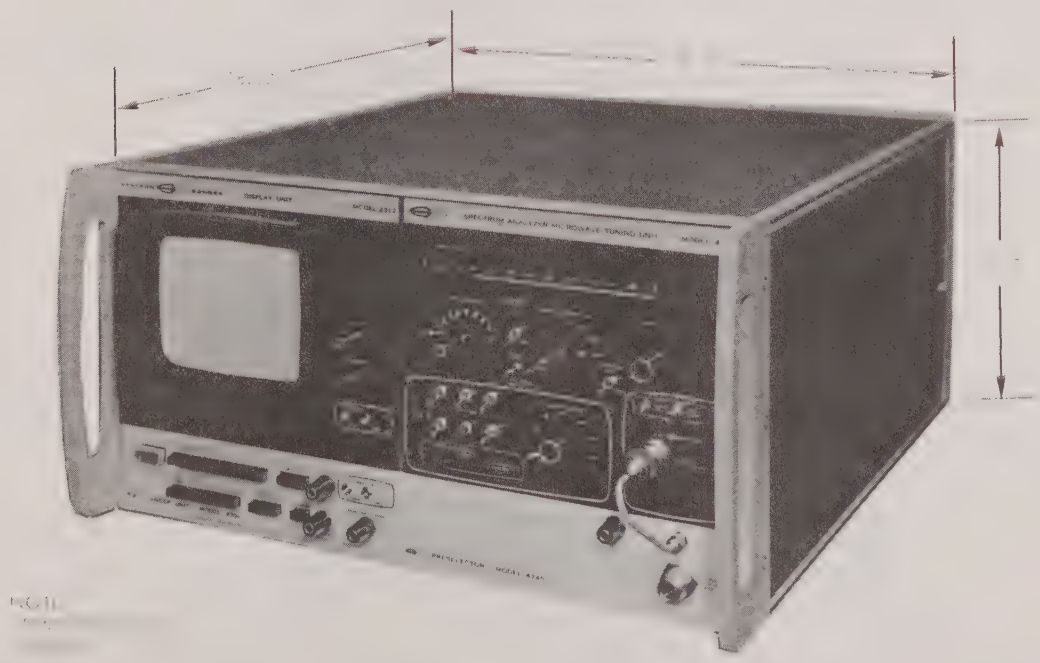


Figure 2-1. Outline Dimensions

2-4. POWER CONNECTIONS (figure 2-2)

The display unit operates from either 115 or 230 volts (±10%), single phase, alternating current with a frequency of between 50 Hz and 70 Hz (400 Hz optional). Typical power dissipation is 100 watts. To make the power connections, refer to figure 2-2, and proceed as follows:

1. Determine whether a 115 volt or 230 volt power source is to be utilized, and perform the following actions, based on the selected line voltage.

   a. Remove line cord from the LINE VOLTAGE connector (3, figure 2-2).

   b. Set the 115V/230V selector switch (1), on the rear panel to the selected line voltage.

   c. Press open the FUSE holder (2) and install the appropriate slow-blow fuse for the selected line voltage (1.5 amp for 115V, 0.75 amp for 230V). Then, close the FUSE holder.

   d. Release the two fasteners for the fan housing on the right side, and open the fan housing, exposing the display subassembly.

   e. Follow the instructions on the display subassembly rear panel to select the line voltage and install the appropriate fuse.

   f. Close and secure the fan housing.

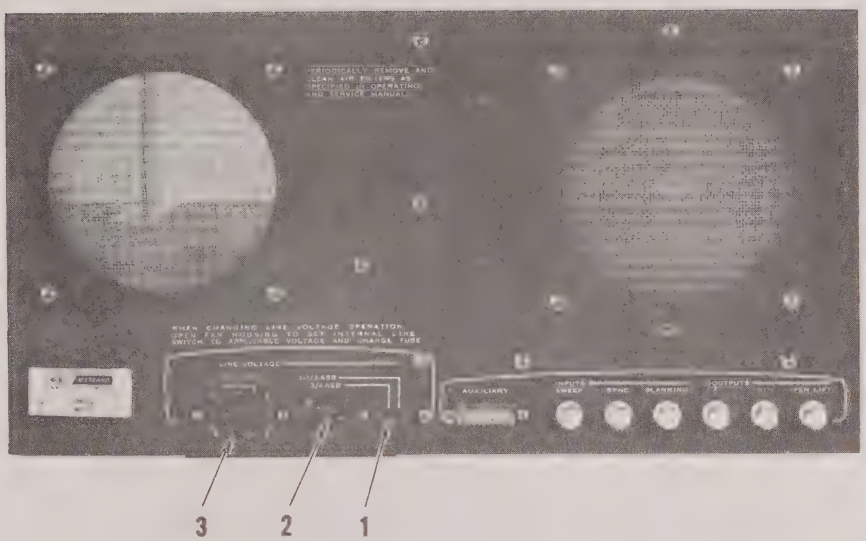
2. Verify that the POWER switch on the sweep control unit is in the OFF position.

3. Connect the power source selected in step 1 to the LINE VOLTAGE connector (3) by means of a three-prong power cable.

WARNING

If the ac line power is being provided from a two-contact outlet, use a two-prong-to-three-prong adaptor, and ground the unit externally with the pigtail lead on the adaptor.

4. On the sweep control unit, press the POWER switch to apply power to the system. Verify that the fan motor begins to operate, and that a trace appears on the CRT in the display subassembly. Then, set the POWER switch to OFF.



1. 11V/230V SELECTOR SWITCH
2. FUSE HOLDER
3. LINE VOLTAGE CONNECTOR

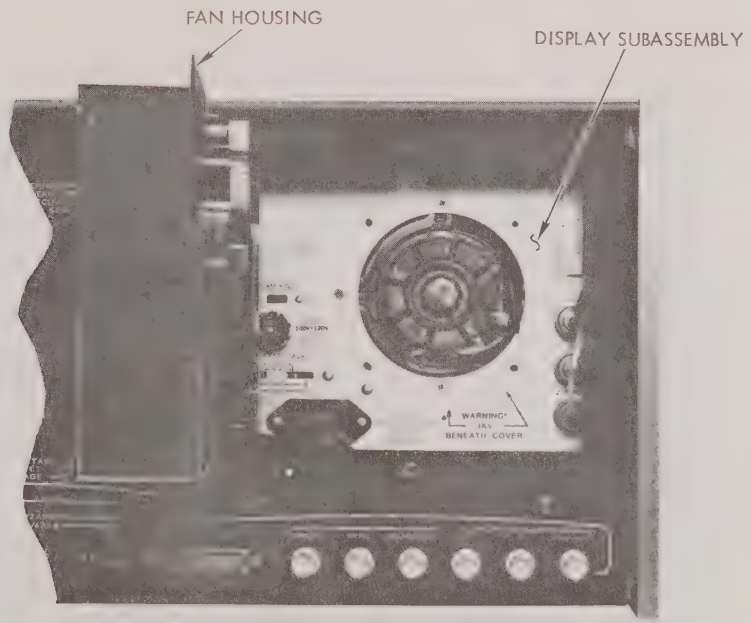


Figure 2-2. Power Connections

SECTION III
DISPLAY UNIT CONTROLS AND EXTERNAL CONNECTORS

3-1. GENERAL

This section describes the controls and external connectors for the Model 2311 and the Model 2312 display units.

3-2. DISPLAY SUBASSEMBLY FRONT PANEL CONTROLS (figures 3-1 and 3-2)

Figure 3-1 illustrates the front panel of the standard persistence display subassembly used in the Model 2312, and figure 3-2 illustrates the front panel of the variable-persistence display subassembly used in the Model 2311.

Table 3-1 lists and describes the front panel controls for the Model 2312 and table 3-2 lists and describes the front panel controls for the Model 2311.

3-3. DISPLAY SUBASSEMBLY REAR PANEL CONTROLS (figures 3-3 and 3-4)

Figures 3-3 and 3-4 illustrate the rear panels of the standard (figure 3-3) or variable persistence (figure 3-4) display subassemblies. Access to the controls and connectors on the rear panel is gained by opening the fan box on the rear of the display unit. Table 3-3 lists and describes the controls and connectors on the rear panel.

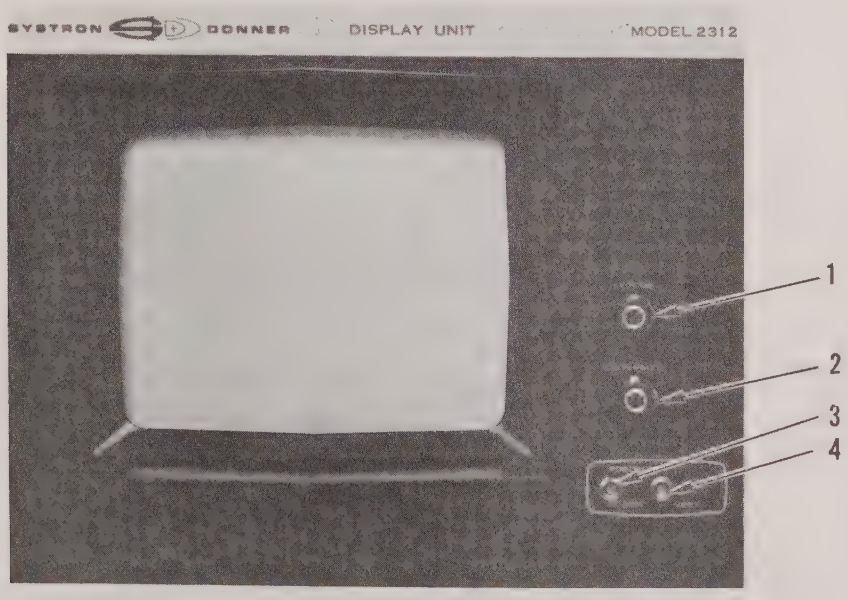


Figure 3-1. Model 2312 Display Subassembly Front Panel

3-4. DESCRIPTION OF CRT DISPLAY

The graticule on the CRT display is 10 divisions wide by 8 divisions high. Each major division is subdivided into 5 minor divisions. The horizontal axis of the display may represent frequency or time or some other axis as determined by the plug-in and/or sweep control.

The vertical axis generally represents the magnitude, where the left hand scale markings are used for LINear display mode (units/DIV) and the right hand scale markings are used for LOGarithmic display (xdB/DIV from full scale reference) as determined by the plug-in.

TABLE 3-1. MODEL 2312 DISPLAY SUBASSEMBLY PANEL CONTROLS

INDEX NO. (fig. 3-1)	CONTROL LABEL AND DESCRIPTION	FUNCTION
1	FOCUS potentiometer	Adjusts the sharpness of the trace.
2	INTENSITY potentiometer	Adjusts the brightness of the trace.
3	HORIZ POSITION potentiometer	Adjusts the horizontal position of the trace.
4	VERT POSITION potentiometer	Adjusts the vertical position of the trace.

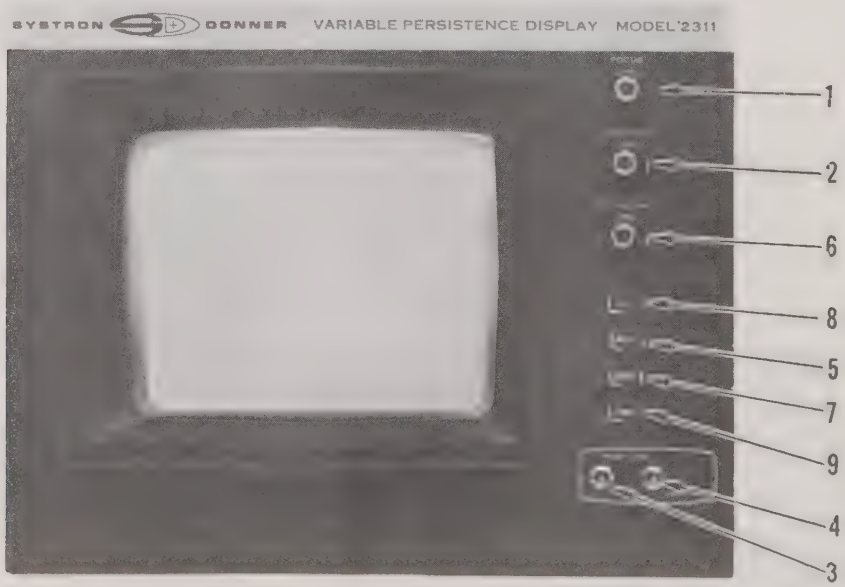


Figure 3-2. Model 2311 Display Subassembly Front Panel

TABLE 3-2. MODEL 2311 DISPLAY SUBASSEMBLY FRONT PANEL CONTROLS

INDEX NO. (fig. 3-2)	CONTROL LABEL AND DESCRIPTION	FUNCTION
1	FOCUS potentiometer	Adjusts the sharpness of the trace.
2	INTENSITY potentiometer	Adjusts the brightness of the trace.
3	HORIZ POSITION potentiometer	Adjusts the horizontal position of the trace.
4	VERT POSITION potentiometer	Adjusts the vertical position of the trace.
5	WRITE pushbutton	Selects operation in the variable persistence mode, and enables storage and erasure of the display.
6	PERSISTENCE potentiometer	Adjusts the persistence of the display in the write mode between 0.2 seconds and 1 minute. The longer the persistence, the longer the display remains on the CRT.
7	STORE pushbutton	Permits a display produced in the WRITE mode to be stored on the CRT for an extended period of time. First, the WRITE mode must be selected, and the PERSISTENCE control is adjusted to obtain the desired display. Then, the STORE pushbutton is pressed to store the display.
8	ERASE pushbutton	Permits removal of a written image produced in the WRITE mode from the CRT. Before pressing the ERASE pushbutton, the WRITE pushbutton must be pressed.
9	CONV pushbutton	Disables the variable persistence, storage, and erase features. In this mode, the Model 2311 operates as a standard persistence X-Y display. The PERSISTENCE control has no effect on the display.

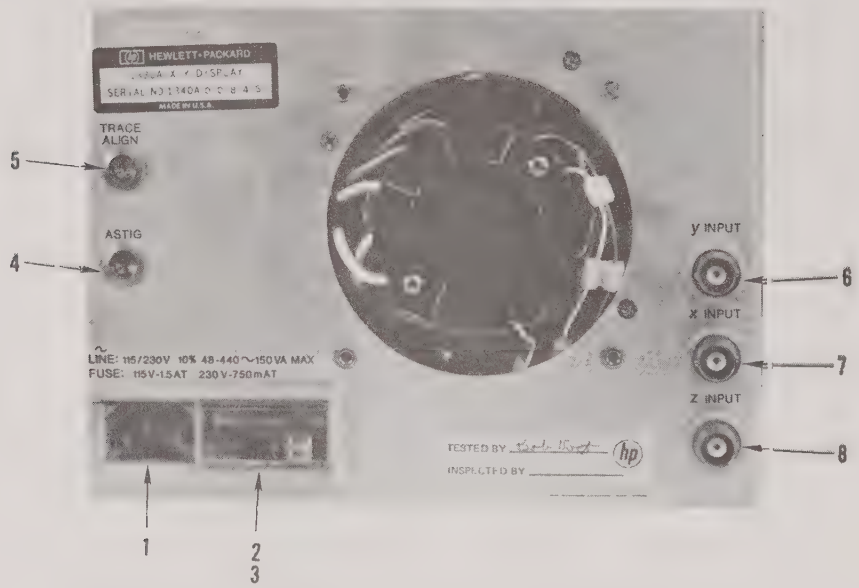


Figure 3-3. Model 2312 Display Subassembly Rear Panel

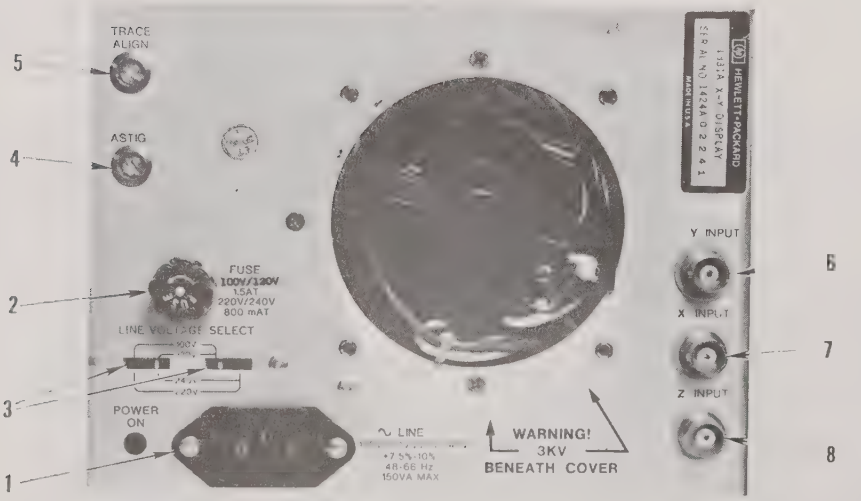


Figure 3-4. Model 2311 Display Subassembly Rear Panel

TABLE 3-3. MODEL 2311 AND MODEL 2312 DISPLAY SUBASSEMBLY REAR PANEL CONTROLS

INDEX NO. (fig. 3-3 or 3-4)	CONTROL LABEL AND DESCRIPTION	FUNCTION
1	LINE connector	Connects display subassembly to input power via connector P101 of display unit.
2	FUSE	Protects display subassembly from current overloads. For 115V operation, a 1.5 amp fuse is installed; for 230V operation, a 0.75 amp fuse is installed.
3	115V/230V Voltage Selector	Set to correspond to the line voltage being utilized. The right-hand position is 115V, and the left-hand position is 230V.
4	ASTIG potentiometer	Adjusts trace dot symmetry. Adjusted to obtain a round trace dot.
5	TRACE ALIGN potentiometer	Aligns trace so that it is parallel with horizontal lines on graticule.
6	Y INPUT connector	Vertical deflection voltage from P107 of display unit is connected to this point.
7	X INPUT	Horizontal deflection voltage from P106 of display unit is connected to this point.
8	Z INPUT	Blanking signal from P108 of display unit is connected to this point.

3-5. REAR PANEL POWER CONNECTOR AND POWER CONTROLS (table 3-4)

The rear panel power connector and power controls on the display unit are illustrated in figure 2-2, and are described in table 3-4.

TABLE 3-4. REAR PANEL POWER CONNECTOR AND POWER CONTROLS

INDEX NO. (fig. 2-2)	CONTROL LABEL AND DESCRIPTION	FUNCTION
1	115V/230V selector switch	Set to correspond to the line voltage being utilized. Pushing the switch to the left selects 115V; pushing the switch to the right selects 230V.
2	FUSE	Protects the fan and the power supply from current overloads. For 115V operation, a 1.5 amp fuse is installed; for 230 operation, a 0.75 amp fuse is installed.
3	LINE VOLTAGE connector	Connects unit to external power source.

3-6. REAR CONNECTOR PANEL (figure 3-5)

Figure 3-5 illustrates the rear connector panel of the display unit, which is used for connecting auxiliary equipment to the sweep control unit. Table 3-5 lists and describes the external connections. Refer to the applicable manual for the sweep control unit to obtain signal specifications.

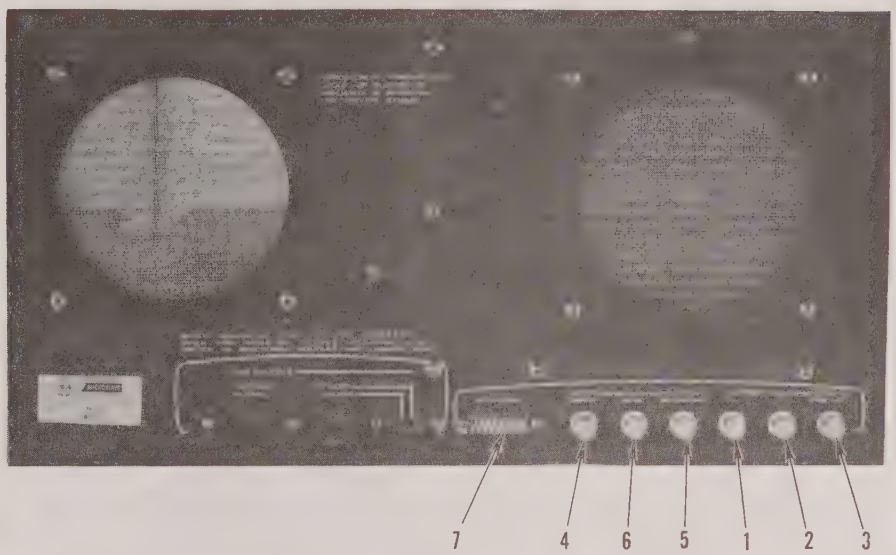


Figure 3-5. Rear Connector Panel

TABLE 3-5. EXTERNAL CONNECTIONS

INDEX NO. (fig. 3-5)	CONNECTOR LABEL	FUNCTION
1	X OUTPUT	Ramp voltage output synchronized with horizontal sweep of CRT and dispersion sweep of tuning unit.
2	Y OUTPUT	Video output derived from the video produced by the tuning unit.
3	PEN LIFT	Two-state signal output indicates whether horizontal retrace or horizontal sweep is in progress.
4	SWEEP INPUT	External input signal permits horizontal sweep and dispersion sweep produced by sweep control unit to be derived from an external ramp voltage.
5	BLANKING INPUT	External input signal permits blanking of the CRT.
6	SYNC INPUT	External input signal permits synchronization of the internal sweep.

TABLE 3-5. EXTERNAL CONNECTIONS (Continued)

INDEX NO. (fig. 3-5)	CONNECTOR LABEL	FUNCTION
7	AUXILIARY	15-pin Cannon connector provides connection for ancilliary external equipment. Signals on this connector include: Pin 1 - Counter Gate. This output signal to the external device serves as an enable command. Pin 2 - Sync Delay. This input from the external device can be used to delay the start of the next sweep. Pin 3 - Sweep Holdoff. This input from the external device can be used to prevent the discharge of present sweep.

SECTION IV
OPERATIONAL PROCEDURES

4-1. GENERAL

This section contains operational procedures for the spectrum analyzer system, including detailed procedures for the display subassembly. Refer to the applicable manuals for the sweep control unit, tuning unit, and aux module for detailed procedures pertaining to these units.

4-2. PRE-OPERATIONAL SET-UP

1. Refer to paragraph 2-4 and make the power connections to the display unit. Set the POWER switch on the sweep control unit to ON.

2. On the display subassembly, set INTENSITY and (for the Model 2311) PERSISTENCE controls fully counterclockwise. For the Model 2311, press the CONV pushbutton.

3. On the sweep control unit, select an internal free-running sweep. Adjust the INTENSITY control as required to obtain a visible trace.

4. Adjust the FOCUS and ASTIG controls, as required, to obtain an optimum trace.

5. On the display subassembly, adjust the VERT POSITION and TRACE ALIGN controls so that the trace line coincides with the lowest horizontal line on the graticule, and adjust the HORIZ position control to center the trace line in the graticule.

6. On the sweep control unit, adjust the HORIZ CAL control so that the trace line extends one minor scale division beyond the far left and far right vertical lines of the graticule. Readjust the HORIZ POSITION control on the display subassembly, and the HORIZ CAL control on the sweep control unit as necessary to obtain this trace width.

7. On the sweep control unit, select Internal Marker or External Sweep Mode.

8. If External Sweep mode was selected in step 7, connect the source of the external sweep signal to the SWEEP INPUT connector on the rear panel. If an external blanking signal is also being utilized, connect the external blanking input to the BLANKING INPUT connector on the rear panel. If the external sweep is to be used to derive the dispersion sweep for the tuning unit, select AUTO sweep on the sweep control unit.

9. If Internal or Marker Sweep Mode was selected in step 7, make the following selections:

   a. Sync mode. If external sync is selected, connect the source of the external sync signal to the SYNC INPUT connector on the rear panel.

   b. Sweeptime per division. A MSec per division or AUTO sweep must be selected if a dispersion sweep is to be produced in the tuning unit.

4-3. SIGNAL ANALYSIS

After performing the pre-operational set-up in paragraph 4-2, signal analysis is performed as follows:

1. For the Model 2311 only, press the CONV pushbutton on the display subassembly.

2. Refer to the applicable manual for the tuning unit, and set up the tuning unit for proper operation.

3. Adjust BASELINE CLIPPER control on the sweep control unit as required to eliminate unnecessary clutter from the display.

4-4. OPERATION IN WRITE MODE (MODEL 2311 ONLY)

The Model 2311 has the capability of displaying the information for a much longer duration in the WRITE mode. Proceed as follows:

1. Press WRITE pushbutton.

2. Adjust INTENSITY and PERSISTENCE controls for the desired display brightness and display duration.

NOTE

Excessive intensity and persistence when writing a display reduces the time that the display can be stored.

3. To store the display, press the STORE pushbutton. To erase the display, after it has been stored, press the WRITE pushbutton, and then press the ERASE pushbutton. With the WRITE pushbutton pressed, a new display is initiated each time the ERASE pushbutton is released.

SECTION V
CIRCUIT DESCRIPTIONS

5-1. GENERAL

This section contains block diagram and circuit descriptions of the display unit. Refer to the Supplement for detailed circuit descriptions of the display subassembly.

5-2. SIMPLIFIED SCHEMATIC/BLOCK DIAGRAM DESCRIPTION (figure 5-1)

Figure 5-1 is a simplified schematic/block diagram of the spectrum analyzer, and includes the circuit details of the display unit.

5-2.1 BLOCK DIAGRAM DESCRIPTION

The sweep control unit generates a horizontal deflection voltage ramp that is supplied to the X INPUT of the display subassembly. This voltage ramp deflects the CRT beam from left to right across the display. In the normal sweep mode (msec/division), the sweep control unit also generates a dispersion sweep ramp that is a derivative of the horizontal voltage ramp supplied to the display subassembly. This dispersion sweep signal is supplied to both the tuning unit and the accessory module, thus the frequency sweep in these units is synchronized to the horizontal deflection of the CRT beam. The video outputs produced by the tuning unit during the sweep are supplied through the VERT CAL control (on the sweep control unit) to the Y INPUT of the display subassembly. The video causes vertical deflection of the CRT beam proportional to the amplitude of the video. Blanking of the CRT is controlled by the blanking signal (from the sweep control unit) to the Z INPUT of the display subassembly. The blanking signal blanks the CRT during horizontal retrace, and can also be used to accomplish baseline blanking.

5-2.2 AC POWER DISTRIBUTION

The 115V/230V line voltage is supplied through LINE VOLTAGE connector J101 to POWER switch S101 on the sweep control unit. When switch S101 is set to ON, the ac power is supplied through the switch to the display subassembly via P101, and is also supplied via FUSE F101 to the following points:

1. Via blower interlock switch S103 to blower fan B101.

2. Via 115V/230V select switch S102 to the primary windings of power transformer T101.

The ac outputs from the four secondary windings of transformer T101 are supplied via connector P109 to the power supply assembly.

5-1.3 POWER SUPPLY

The power supply assembly contains four separate power supplies that produce the dc voltages required by the sweep control unit, the tuning unit, and the accessory module. In addition, the 9.5 VAC output of power transformer T101 is supplied as the Line Sync signal to the sweep control unit, where it is used to synchronize the sweep when the LINE SYNC sweep trigger mode is selected. The four power supplies

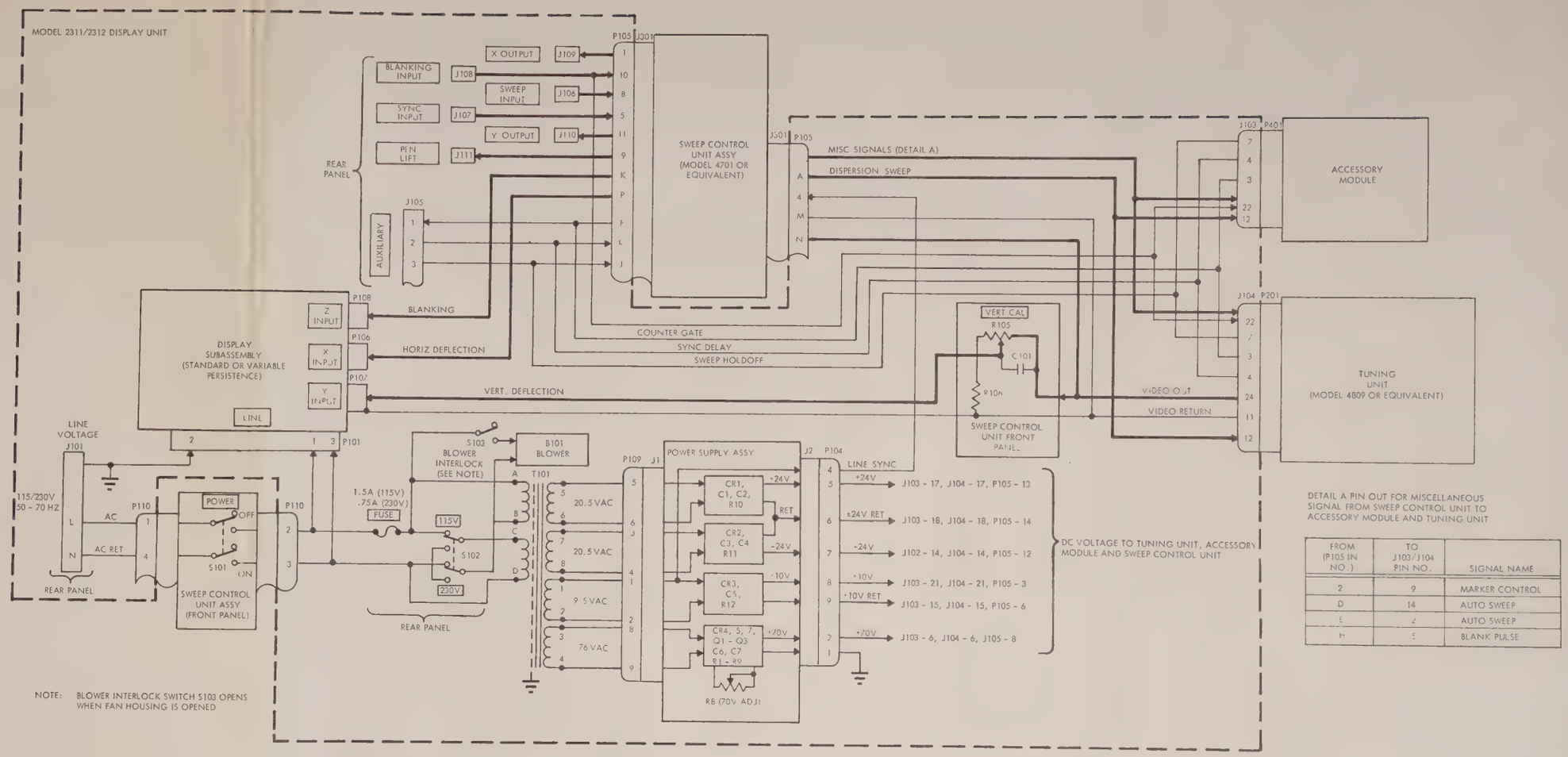
in the power supply assembly are described in the paragraphs that follow.

5-2.3.1 +24V POWER SUPPLY. One of the two 20.5 Vac secondary windings of transformer T101 is connected to full-wave bridge rectifier CR1. The rectified dc voltage from CR1 is filtered by capacitors C1 and C2, to produce the unregulated +24V output.

5-2.3.2 -24V POWER SUPPLY. One of the two 20.5 Vac secondary windings of transformer T101 is connected to full-wave bridge rectifier CR2. The rectified dc voltage from CR2 is filtered by capacitors C3 and C4, to produce the unregulated -24V output.

5-2.3.3 +10V POWER SUPPLY. The 9.5 Vac secondary winding of transformer T101 is connected to full-wave bridge rectifier CR3. The rectified dc voltage from CR3 is filtered by capacitor C5 to produce the +10V output.

5-2.3.4 +70V POWER SUPPLY. The 76 Vac secondary winding of transformer T101 is connected to full-wave bridge rectifier CR4. The rectified dc voltage from CR4 is filtered by capacitor C6, and supplied to a voltage regulator consisting of transistors Q1 through Q3, and zener diodes CR5 and CR7. The regulated +70V output can be adjusted by 70V adjust R8.



DETAIL A PIN OUT FOR MISCELLANEOUS SIGNAL FROM SWEEP CONTROL UNIT TO ACCESSORY MODULE AND TUNING UNIT

FROM (P105 IN NO.)	TO J103/J104 PIN NO.	SIGNAL NAME
2	9	MARKER CONTROL
D	14	AUTO SWEEP
L	2	AUTO SWEEP
H	5	BLANK PULSE

Figure 5-1. Simplified Schematic/Block Diagram

SECTION VI
PERFORMANCE CHECKS AND ADJUSTMENTS

6-1. GENERAL

This section contains performance checks and adjustments for the Model 2311 or Model 2312 display unit. Refer to the applicable manuals for the sweep control unit, tuning unit, and accessory module for performance checks and adjustments of these units.

6-2. PERFORMANCE CHECKS AND ADJUSTMENTS.

Performance checks of the display unit consist of verifying that all dc voltages are correct, and that the display subassembly operates correctly. The only adjustment covered in this procedure is for the regulated +70V output of the power supply. Refer to the appendix for adjustments in the display subassembly. Proceed as follows to check out and adjust the display unit:

1. Remove the tuning unit, and set the POWER switch on the sweep control unit to ON.

2. Using a digital voltmeter, make the following voltage checks at connector J103 (the connector that connects to the tuning unit):

From	To	Voltage
Pin 17(+)	Pin 18(-)	+27V
Pin 19(-)	Pin 18(+)	-27V
Pin 21(+)	Pin 15(-)	+10V
Pin 6 (+)	Pin 1 (-)	+70V *

* (adjust R8 on power supply assembly to obtain correct voltage)

3. Perform the performance checks given in the supplement for the display subassembly. If performance checks are unsatisfactory, locate fault in display subassembly.

SECTION VII
TROUBLESHOOTING

7-1. GENERAL

This section contains troubleshooting information for the Model 2311 or Model 2312 display unit. Refer to the applicable manuals for the sweep control unit, tuning unit, and accessory module for troubleshooting of these units. Refer to the supplement for troubleshooting of the display subassembly.

7-2. TROUBLE ANALYSIS (table 7-1)

Table 7-1 provides troubleshooting information for the display unit.

TABLE 7-1. TROUBLESHOOTING CHART

TROUBLE SYMPTOMS	ISOLATION PROCEDURE
Blower fan B101 fails to operate when power is applied.	1. Check FUSE F101, and replace if blown. 2. If fuse is OK, check fan motor B101 and interlock switch S103. 3. Check POWER switch S101 on sweep control unit. If switch checks ok, locate fault in wiring.
All dc voltages from power supply are at 0 volts. Blower fan operates normally when power is applied.	Check transformer T101 for an open primary winding. If transformer T101 checks OK, check 115V/230V switch S102.
All dc voltages from power supply are abnormally high or abnormally low.	Verify that 115V/230V switch S102 is set to the line voltage being utilized. If switch is set correctly, check transformer T101.
One dc voltage from power supply assembly is abnormal; all other dc voltages are normal.	1. Disconnect sweep control unit, remove tuning unit, and check abnormal voltage again. 2. If voltage returns to normal when all units are disconnected, locate short in sweep control unit, or tuning unit. 3. If voltage is still abnormal with all units disconnected, check associated secondary winding of transformer T101. If T101 checks OK, fault is in power supply assembly.
No vertical or horizontal deflection.	Refer to supplement to isolate fault in display subassembly

TABLE 7-1. TROUBLESHOOTING CHART (Continued)

TROUBLE SYMPTOMS	ISOLATION PROCEDURE
No horizontal deflection. Vertical deflection is normal.	Introduce an audio signal to the X INPUT of display subassembly. If no horizontal deflection is produced, refer to supplement, and troubleshoot the display subassembly. If horizontal deflection is produced, introduce the audio signal at pin P of P105. If horizontal deflection is produced, troubleshoot the sweep control unit. If no horizontal deflection is produced, locate defective wiring in cable harness.
No vertical deflection. Horizontal deflection is normal.	Introduce a video signal at Y INPUT of display subassembly. If no vertical deflection is produced, refer to appendix, and troubleshoot the display subassembly. If vertical deflection is produced, introduce the video signal at pin 24 of J104. If vertical deflection is produced, troubleshoot the tuning unit. If no vertical deflection is produced, locate defective wiring in cable harness.
Operation is normal in CONV mode, but is abnormal in WRITE mode (Model 2311 only)	Refer to the supplement, and troubleshoot display assembly.

7-3. REMOVAL OF DISPLAY SUBASSEMBLY

To remove the display subassembly from the display unit, proceed as follows:

1. Disconnect power; remove the tuning unit, left side cover, and top cover.
2. Remove the screws that secure the left corner trim, and remove the corner trim so that it is possible to slide out the left side panel.
3. Release the two fasteners that secure the fan box and swing open the fan box.
4. Disconnect the cables from the display unit to the LINE, X INPUT, Y INPUT, and Z INPUT connectors on the rear panel of the display subassembly.
5. Remove the three screws securing the left side of the display subassembly.
6. Remove the five screws securing the right side of the display subassembly.
7. Slide the display subassembly straight out from the front of the display unit.

7-4. REPLACEMENT OF DISPLAY SUBASSEMBLY

To replace the display subassembly in the display unit, proceed as follows:

1. Line up the display subassembly with the compartment in the display unit, and slide the unit in, aligning the front panel edges of the display subassembly with the edges of the display unit.

2. Secure the display subassembly in place with the eight screws removed in steps 5 and 6 of paragraph 7-3.

3. Connect the cables from the display unit to the LINE, X INPUT, Y INPUT, and Z INPUT connectors on the rear panel of the display subassembly.

4. Install the left side panel removed in step 4 of paragraph 7-3, engage the carrying strap on the rear corner trim, and secure with the two screws removed in step 4 of paragraph 7-3.

5. Close the fan housing, and secure the two fasteners.

6. Reinstall the tuning unit in the display unit.

SECTION VIII

REPLACEABLE PARTS LISTS

8-1. INTRODUCTION

This section lists replaceable parts for the Model 2311 and 2312 Display Units.

8-2. EXPLANATION OF COLUMNS

FIGURE NO. This column references the figure number in which the part can be located.

REFERENCE DESIGNATION. Parts are listed in sequence by reference designation and may be located on the schematic diagram or other referenced figure by this designator.

PART NUMBERS. Standard parts are identified by both a Systron-Donner and the standard part number. Non-standard parts not manufactured or controlled by Systron-Donner are identified by both a Systron-Donner and the manufacturer's part number.

MFR. The five-digit federal manufacturers code, as listed in Cataloging Handbooks H4-1 and H4-2, are listed in this c olumn. These codes and corresponding manufacturers are listed following paragraph 7-3.

DESCRIPTION. Descriptions of component parts are indented to indicate the parts comprising each subassembly. Parenthetical notes are included to indicate parts not common to all models.

8-3. MANUFACTURERS' CODES

CODE	NAME
01963	Cherry Electrical Products Corp. Waukegan, Ill
04713	Motorola Inc., Semiconductor Products Div. Pheonix, Arizona
05245	Components Corp. Chicago, Ill
05820	Wakefield Engineering, Inc. Wakefield, Ma
14655	Cornell-Dublier Electronics Div. of Federal Pacific Electric Co., Newark, N.J.
15933	Systron-Donner Corp, Datapulse Div. Culver City, Calif.

CODE	NAME
21604	The Buckeye Stamping Co. Columbus, Ohio
27264	Molex Products Co. Downers Grove, Ill
56289	Spraque Electric Co. North Adams, Ma
71450	CTS Corp Elkhart, Ind.
71468	ITT Cannon Electric Santa Ana, Calif.
75915	Littelfuse, Inc. Des Plaines, Ill
82877	Rotron, Inc. Woodstock, N.Y.

9-2		10901001			POWER SUPPLY, BOARD ASSY Consisting of:	1
	C1 thru C4	107014	39D308G030JS4	56289	CAPACITOR, ELECTROLYTIC, 3000 uf	4
	C5	107015	39D808G015JT4	56289	CAPACITOR, ELECTROLYTIC, 8000 uf	1
	C6	107012	BR 50-150	14655	CAPACITOR, ELECTROLYTIC, 50 uf	1
	C7	107013	BR 20-150	14655	CAPACITOR, ELECTROLYTIC, 20 uf	1
	CR1, CR2, CR3	107008	MDA-970-1	04713	RECTIFIER, QUAD	3
	CR4	107007	MDA-920A-5	04713	RECTIFIER, QUAD	1
	CR5	107006	1N935		DIODE, ZENER	1
	CR7	107010	1N526B		DIODE, ZENER	1
	J1, J2	107001	09-66-1061	27264	CONNECTOR, 6 PIN	2
	J1, J2	107002	09-66-1021	27264	CONNECTOR, 2 PIN	2
	Q1	107011	2N3641		TRANSISTOR	1
	Q2	101420	2N3440		TRANSISTOR	1
	Q3	107045	2N699		TRANSISTOR	1
	R1	101471	RC20GF103J		RESISTOR, 10K, 1/2W, 5%	1
	R2	101570	RC07GF103J		RESISTOR, 10K, 1/4W, 5%	1
	R3	101623	RC07GF184J		RESISTOR, 180K, 1/4W, 5%	1
	R4	101569	RC07GF102J		RESISTOR, 1K, 1/4W, 5%	1
	R5	101996	RC07GF6R8J		RESISTOR, 6.8K, 1/4W, 5%	1
	R6	101570	RC07GF103J		RESISTOR, 10K, 1/4W, 5%	1
	R7	107258	RN55D2432F		RESISTOR, 24.3K, 1/8W, 1%	1
	R8	107009	362Y 103B	71450	RESISTOR, VARIABLE, 10K	1
	R9	107025	RN55D4322F		RESISTOR, 43.2K, 1/8W, 1%	1
	R10, R11, R12	101545	RC20GF242J		RESISTOR, 2.4K, 1/2W, 5%	3
		107005	NF207	05820	HEAT SINK	1
9-1	B101	107082	MU2A1	82877	FAN	1
	F101	100591	31301.5	75915	FUSE, 1-1/2A, SB	1
	F101	107133	313-750	75915	FUSE, 3/4A, SB	1
	J101	107079	6EF1 E1 6A	05245	LINE FILTER	1
	J105	107081	DA15S	71468	CONNECTOR	1
	J106 thru J111	101170	UG-1094A/U		RECEPTACLE, RF, BNC	6
	S102	107080	15310-003	15933	SWITCH, 115/230	1
	S103	107140	E16-00M	01963	SWITCH	1
	T101	109011			TRANSFORMER	1
		109004			X-Y DISPLAY UNIT ASSY (MODEL 2311 ONLY) Consisting of:	1
		109005			X-Y DISPLAY UNIT (MODEL 2311 ONLY) (See Supplement for parts breakdown)	1
		109006			PANEL ASSY (MODEL 2311 ONLY)	1
		107101	IRQ-5000-1-BLK	21604	KNOB	3
		109246			X-Y DISPLAY UNIT ASSY (MODEL 2312 ONLY) Consisting of:	1
		109245			X-Y DISPLAY UNIT (MODEL 2312 ONLY) (See Supplement for parts breakdown)	1
		109169			PANEL (MODEL 2312 ONLY)	1
		102101	IRQ-5000-1-BLK	21604	KNOB	1
		109009			BOTTOM COVER ASSY Includes:	1
		107073			BAIL & FOOT ASSY	1
		A109113			FEET	2

109007			CHASSIS ASSY, DISPLAY UNIT Includes:	1
109023			TRIM, FRONT	2
109031			PIN, GUIDE	1
109033			PIN, GUIDE	1
109032			TRIM, SIDE	4
109264			GUIDE PIN ROLLER	1
107088			CORNER TRIM	2
107083	33000-322	15933	FILTER HOUSING	2
107084	32000-910	15933	FILTER SCREEN	2
107078	348-6-7-7	75915	FUSE HOLDER (BLACK)	1
107086			HANDLE	2
109017			HANDLE, FRONT TRIM	2
109012			MAIN HARNESS ASSY	1
109016			POWER CORD	1
107089			POWER CORD	1
109013			POWER SUPPLY, HARNESS ASSY	1
107085			SIDE COVER	2
109014			TOP COVER	1

SECTION IX
CIRCUIT DIAGRAMS

This section contains the following diagrams:

Figure	Title	Page
9-1	Display Unit, Wiring Diagram	9-3
9-2	Power Supply, Schematic Diagram	9-5

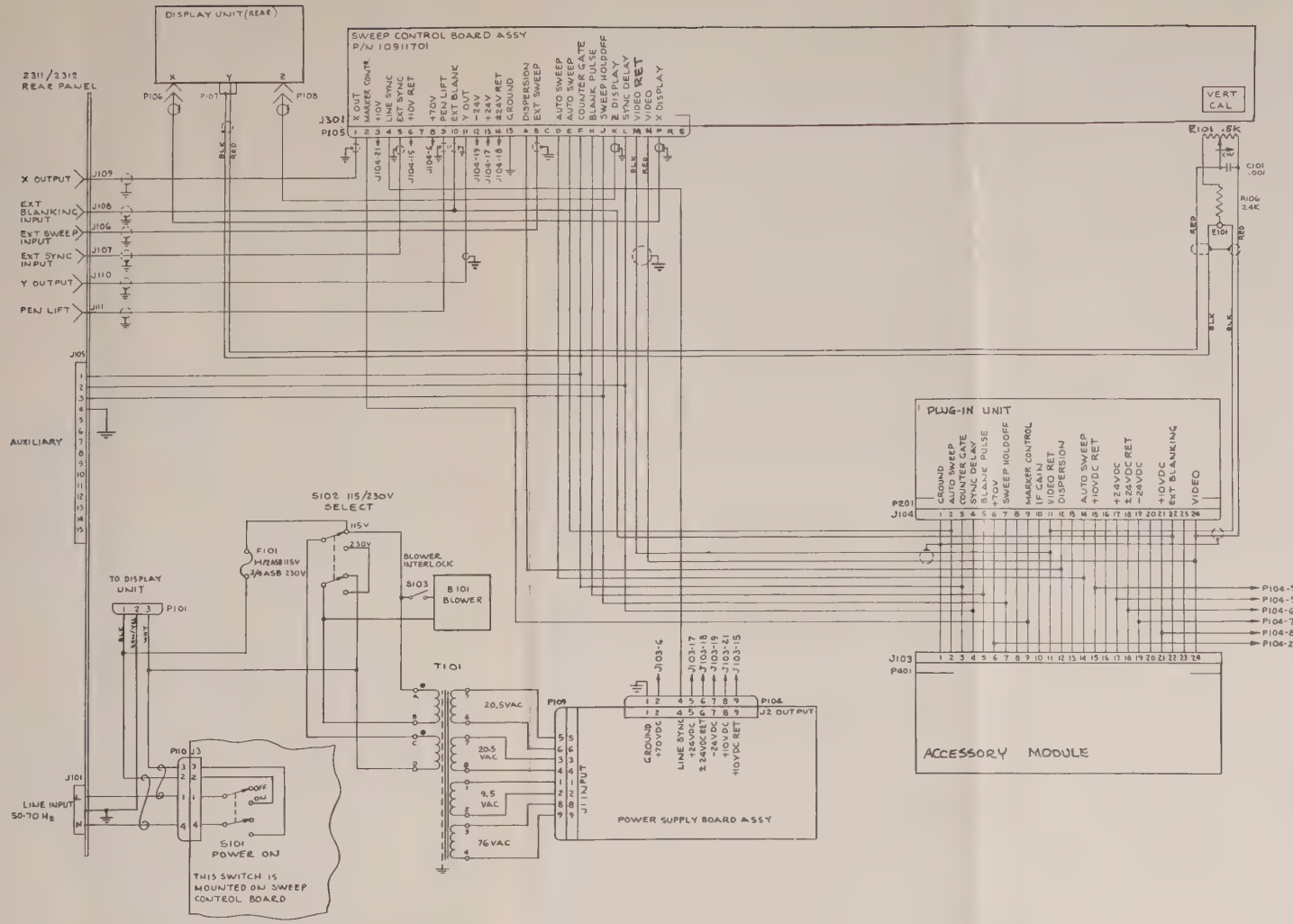
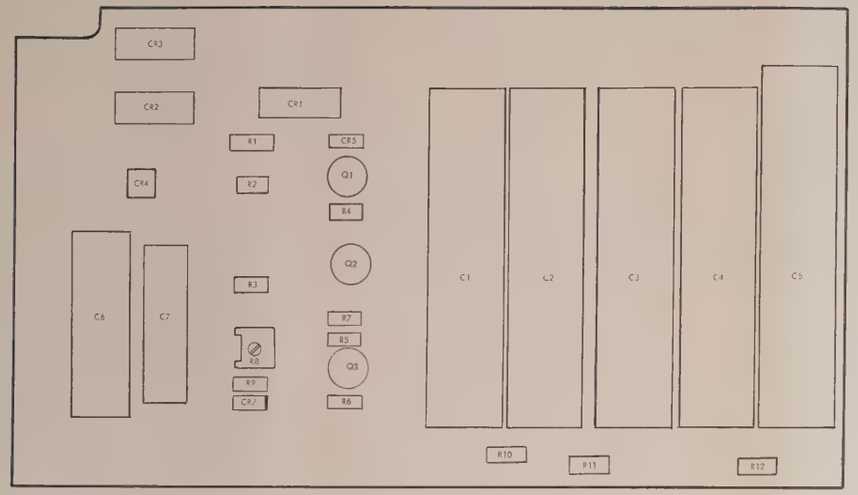
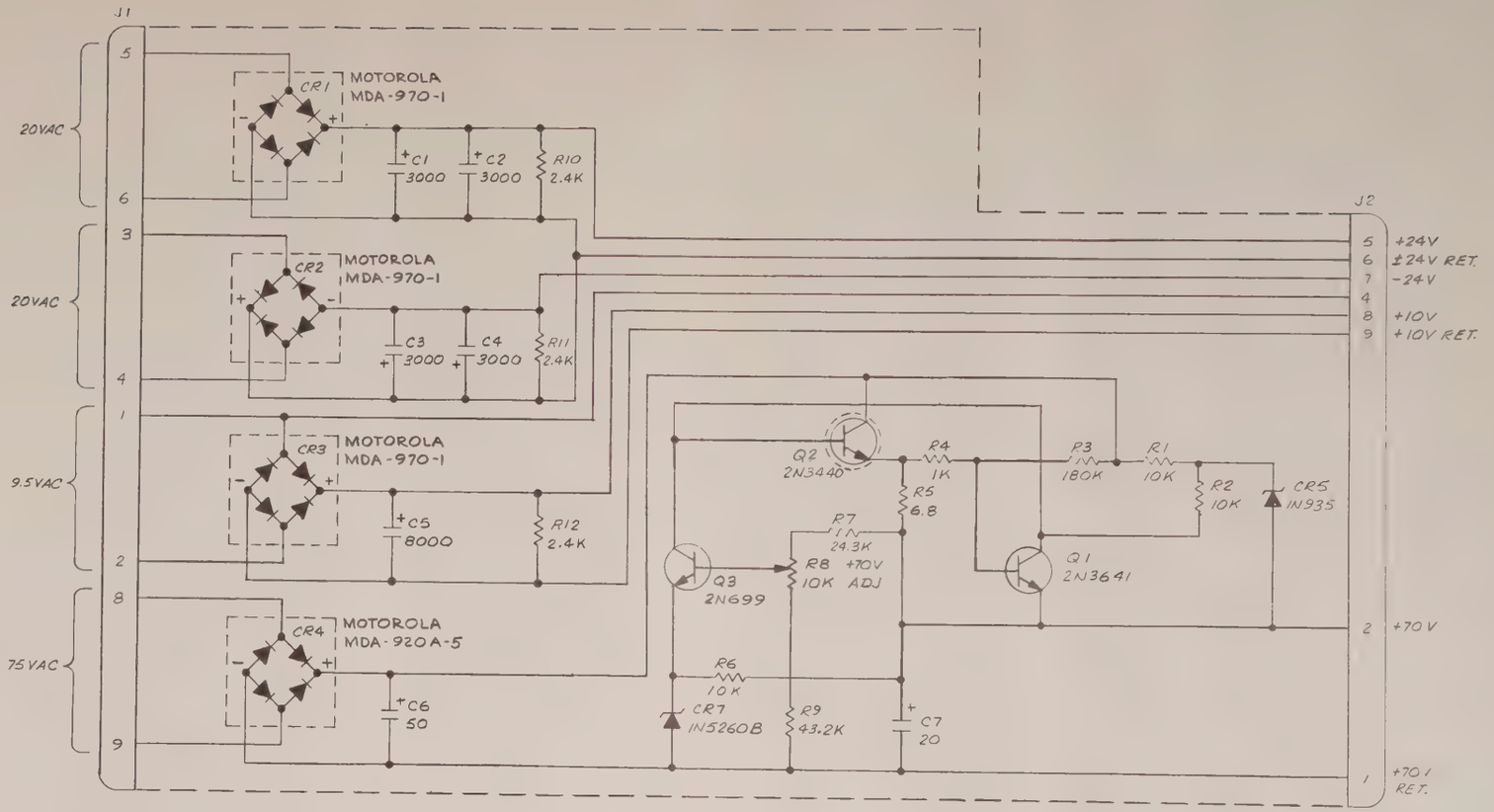


Figure 9-1. Display Unit, Wiring Diagram





NOTES: UNLESS OTHERWISE SPECIFIED

1.- ALL CAPACITOR VALUES ARE IN MICRO-FARADS.

2.- ALL RESISTOR VALUES ARE IN OHMS

Figure 9-2. Power Supply, Schematic Diagram

MANUAL CHANGES

MODEL 1331A

X-Y DISPLAY

Manual Serials Prefixed: 1424A
Manual Printed: JUNE 1974

Make all changes listed below as Errata. Check the following table for your instrument serial prefix and/or serial number and make listed change(s) to the manual:

Serial Prefix or Number	Make Changes	Serial Prefix or Number	Make Changes
1446A	1		
1448A	1, 2		
1513A	1 thru 3		
1536A	1 thru 3		

ERRATA

Page 5-7, paragraph 5-29,
Add following statement to step c:
Output shall be +50V ± 1V.

Page 5-9, figure 5-8,
Replace with figure 5-8 as follows.

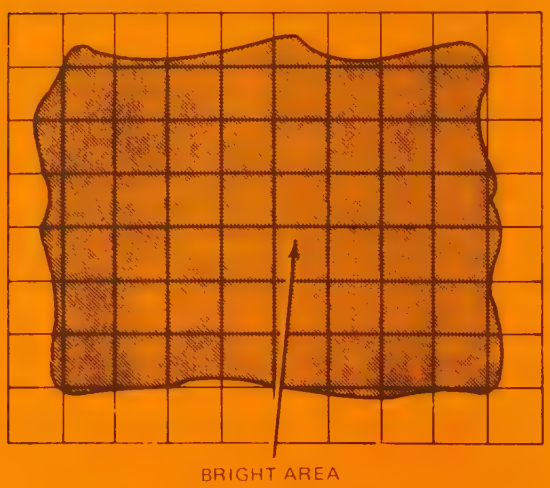


Figure 5-8. Overcollimated CRT

Table 6-2,
Add: J4, HP Part No. 1251-2357, CONNECTOR-AC PWR HP9 MALE FLG MTG, Mfr Code 00180, Mfr Part No. 6061-3.
L1: Change HP Part No. and Mfr Part No. to 01200-66001.
MP18: Change reference designator to MP19, and change HP Part No. and Mfr Part No. to 01331-44701.
MP19: Change reference designator to MP18.
Δ MP31: Change HP Part No. and Mfr Part No. to 5060-0519.

Table 6-2 (Cont'd),
Add: S1, HP Part No. 3101-0890, SWITCH: TGL SPDT, Mfr Code 28480, Mfr Part No. 3101-0890.
Add: S3, HP Part No. 3101-1609, SWITCH: SLIDE 2-DPDT, Mfr Code 82389, Mfr Part No. 11E-1036.
TB1: Change HP Part No. and Mfr Part No. to 01200-26521.
W6: Change to HP Part No. 8120-1992, CABLE, MALE NEMA, Mfr Code 28480, Mfr Part No. 8120-1992.
Add: A1Q35, HP Part No. 1854-0358, TRANSISTOR NPN SI PD=310MW FT=60MHZ, Mfr Code 28480, Mfr Part No. 1854-0358.
A1Q43: Change to HP Part No. 1854-0691, TRANSISTOR NPN SI, Mfr Code 28480, Mfr Part No. 1854-0691.
A1Q57: Change to HP Part No. 1854-0071, TRANSISTOR NPN SI PD=300MW FT=200MHZ, Mfr Code 28480, Mfr Part No. 1854-0071.
Delete: A2C13.
Δ A4C1: Change to HP Part No. 0140-0156, CAPACITOR-FXD 1500 PF +—2% 300WVDC, Mfr Code 72136, Mfr Part No. DM19F152G0300WV1CR.
Add: A4C6, HP Part No. 0140-0196, C:FXD MICA 150 PF 5%, Mfr Code 72136, Mfr Part No. RDM15F151J3C.
Add: A4C7, HP Part No. 0160-2145, C:FXD CER 5000 PF +80—20% 100VDCW, Mfr Code 91418, Mfr Part No. TA.
Δ A4R4: Change to HP Part No. 0684-1021, RESISTOR-FXD 1K 10% .25W CC TUBULAR, Mfr Code 01121, Mfr Part No. CB1021.
Δ A4R5: Change to HP Part No. 0757-0437, RESISTOR-FXD 4.75K 1% .125W F TUBULAR, Mfr Code 24546, Mfr Part No. C4-1/8-TO-4751-F.

12 September 1975
Δ = Latest additions to this change sheet.
This change sheet supersedes all prior change sheets for this manual.

Supplement A for
01331-90906

ERRATA (Cont'd)

Table 6-2 (Cont'd),
Delete: A4R34.
Add: A4R35, HP Part No. 0683-1035, R:FXD COMP 10K OHM 5% 1/4W, Mfr Code 01121, Mfr Part No. CB 1035.
Add: A4R36, HP Part No. 0683-5605, R:FXD COMP 56 OHM 5% 1/4W, Mfr Code 01121, Mfr Part No. CB 5605.
Add: A4VR1, HP Part No. 1902-0025, DIODE: BREAKDOWN 10.0V 5% 400 MW, Mfr Code 04713, Mfr Part No. SZ–10939–182.

Page 8-14, figure 8-7,
Replace with new figure 8-7, supplied with this manual changes sheet.
Schematic 2,
Replace with schematic 2 supplied with this manual changes sheet.
Schematic 4,
Delete: A2C13.
Schematic 5,
A1Q60: Show cathode connected to ground and anode connected to +12.6V. Trigger connection is correct.

CHANGE 1

Table 6-2,
W7: Change HP Part No. and Mfr Part No. to 01331-61633.

CHANGE 2

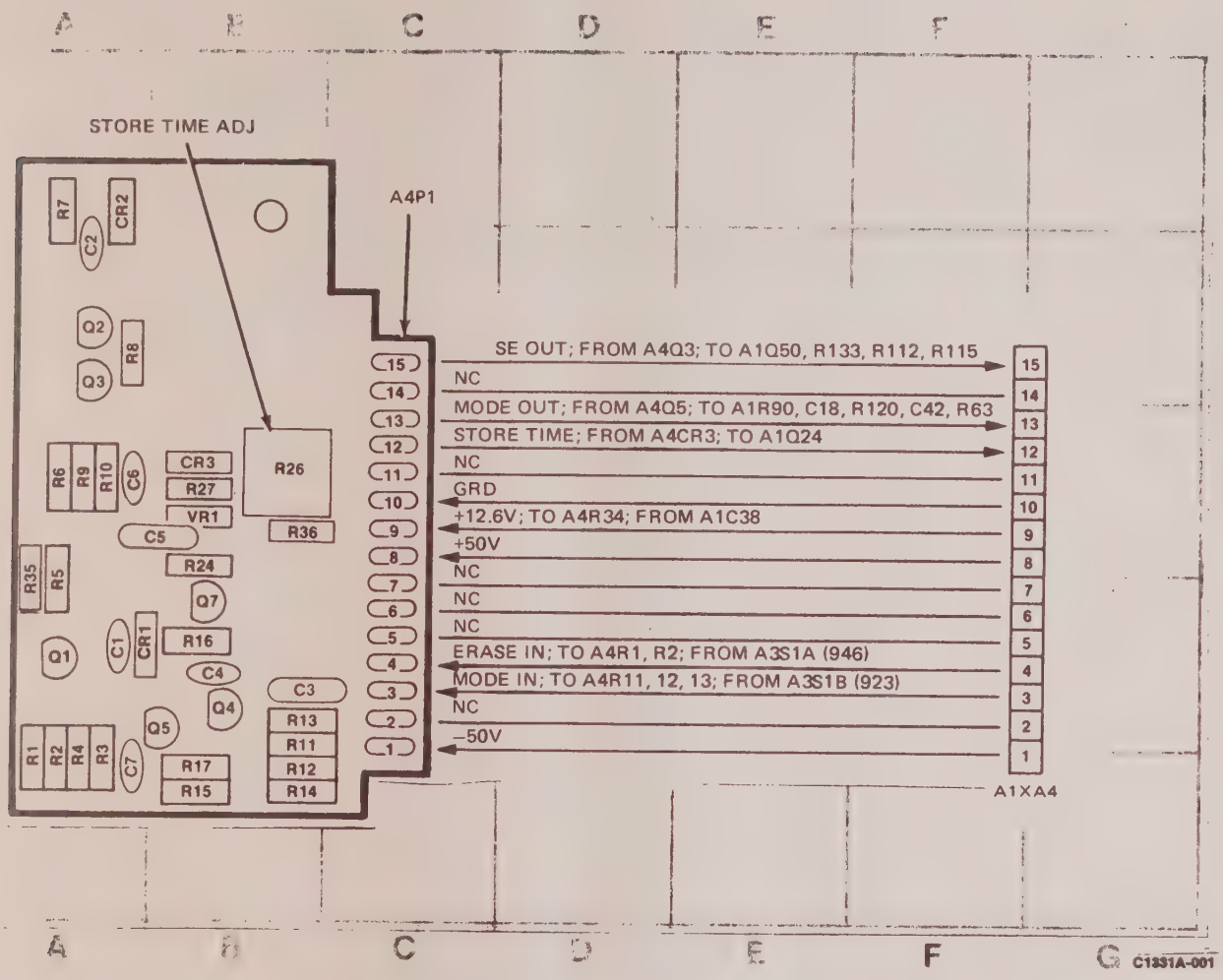
Page 3-3, figure 3-1,
Delete: BEAM FIND switch on rear panel (item H).
Add: GEOMETRY control on rear panel. List as item K. GEOMETRY. Adjusts for rectangular display with straight vertical and horizontal edges (minimum pincushioning and barreling).
Table 6-2,
MP9. Change HP Part No. and Mfr Part No. to 01331-00216.
Add: R10, HP Part No. 2100-2361, RESISTOR: VAR 100K 10% 0.5W CC LIN, Mfr Code 01121, Mfr Part No. TYPE W.
Delete: S1.
W7: Change HP Part No. and Mfr Part No. to 01331-61635.

Schematic 1,
Delete: BEAM FIND switch S1 and associated wiring to A1.
Connect jumper (wire color 91) across the two open BEAM FIND terminals.
Schematic 4,
Delete: Signal no. 2 connection from V1 to A1.
Add: GEOMETRY control R10 (100K variable) as rear-panel adjustment. Show wiper of R10 connected to V1, pin NP through a white/blue wire. Show resistance of R10 connected from +158V (red wire) to chassis ground (black wire).

CHANGE 3

Table 6-2,
A1. Change HP Part No. and Mfr Part No. to 01331-66537.
Add: A1C43, HP Part No. 0160-0820, CAPACITOR-FXD .05UF +80–20% 25WVDC CER, Mfr Code 56289, Mfr Part No. C080B250G503ZS27-CDE.

Schematic 3,
Add: A1C43 (.05 UF) between collector of A1Q52 and ground.



REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	A-4	R5	A-4
C2	A-2	R6	A-3
C3	B-4	R7	A-1
C4	B-4	R8	A-2
C5	B-3	R9	A-3
C6	B-6	R10	A-3
C7	A-5	R11	B-4
CR1	A-4	R12	B-5
CR2	A-1	R13	B-4
CR3	B-3	R14	B-5
Q1	A-4	R15	B-5
Q2	A-2	R16	B-4
Q3	A-2	R17	B-5
Q4	B-4	R24	B-3
Q5	B-4	R26	B-3
Q7	B-4	R27	B-3
R1	A-5	R35	A-3
R2	A-5	R36	B-3
R3	A-5	VR1	B-3
R4	A-5		

Figure 8-7. Service Information - Program Circuits - Assemblies A3, A4 (Sheet 1 of 2)

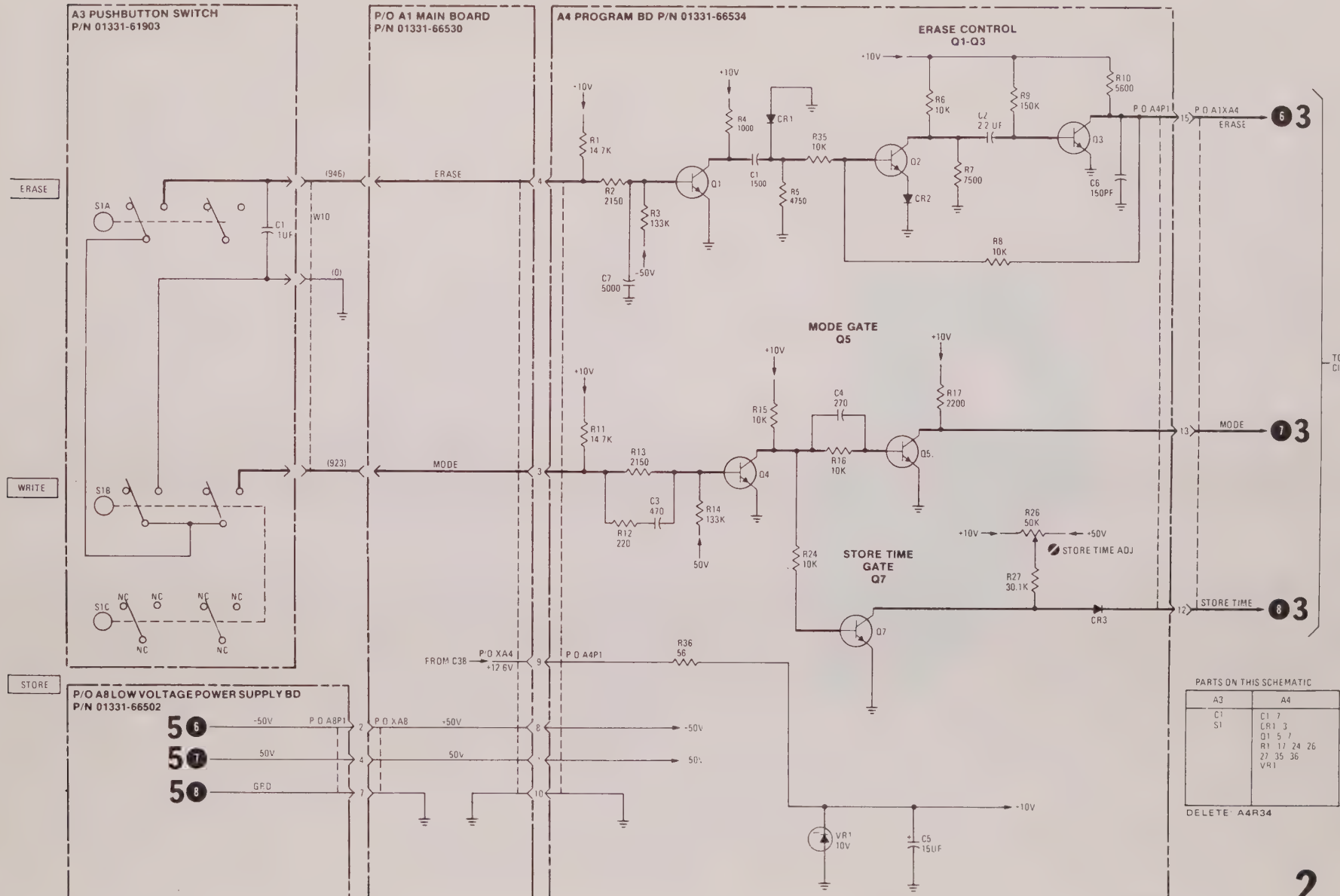
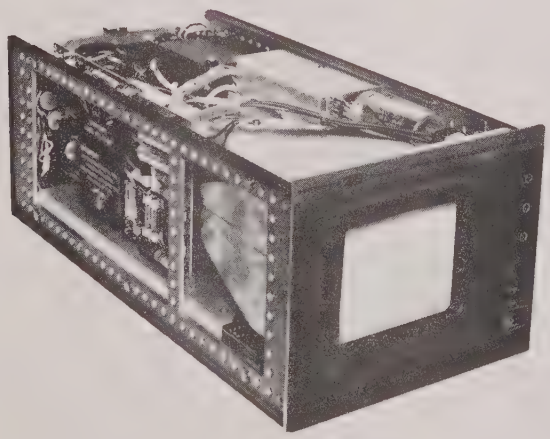


Figure 8-
Service Information - Program Circuits - Assemblies A3, A4 (sheet 2 of 2
8-1

SUPPLEMENT

MODEL 2311 VARIABLE PERSISTENCE DISPLAY UNIT
AND
MODEL 2312 STANDARD PERSISTENCE DISPLAY UNIT

This supplement provides service information for the Display Subassembly, Part No. 109004 used in the Model 2311 Variable Persistence Display Unit. Refer to the basic manual for operational procedures and removal and replacement instructions.



SUPPLEMENT
DISPLAY SUBASSEMBLY
PART NO. 109004

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OPERATING AND SERVICE MANUAL

MODEL 1331A
X-Y DISPLAY

SERIALS PREFIXED: 1424A

Refer to Section VII for instruments with other Serial Prefixes.

Refer to Section VII for instruments with the following standard options: **X95**, **002**, and **631**.

HEWLETT-PACKARD COMPANY/COLORADO SPRINGS DIVISION
1900 GARDEN OF THE GODS ROAD, COLORADO SPRINGS, COLORADO, U.S.A.

Manual Part Number 01331-90906
Microfiche Part Number 01331-90806

PRINTED JUNE 1974

SAFETY SUMMARY

The following are general safety precautions that are not related to any specific procedures and therefore do not appear elsewhere in this manual. It is the user's responsibility to understand and apply these safety precautions during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of this instrument.

GROUND THE INSTRUMENT.

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE.

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS.

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid casualties, always remove power and discharge a circuit before touching it.

DO NOT SERVICE OR ADJUST ALONE.

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

USE CAUTION WHEN EXPOSING OR HANDLING THE CRT.

Breakage of the cathode ray tube (CRT) causes a high velocity scattering of glass fragments (implosion). To prevent CRT implosion, avoid rough handling or jarring of the instrument. Handling of the CRT shall be done only by qualified maintenance personnel using approved safety mask and gloves.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT.

Becauses of the danger of introducing additional hazards, substitute parts must not be installed and the instrument must not be modified in any way. Returning the instrument to a Hewlett-Packard Sales and Service Office for service and repair will ensure that safety features are maintained.

DANGEROUS PROCEDURE WARNINGS.

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

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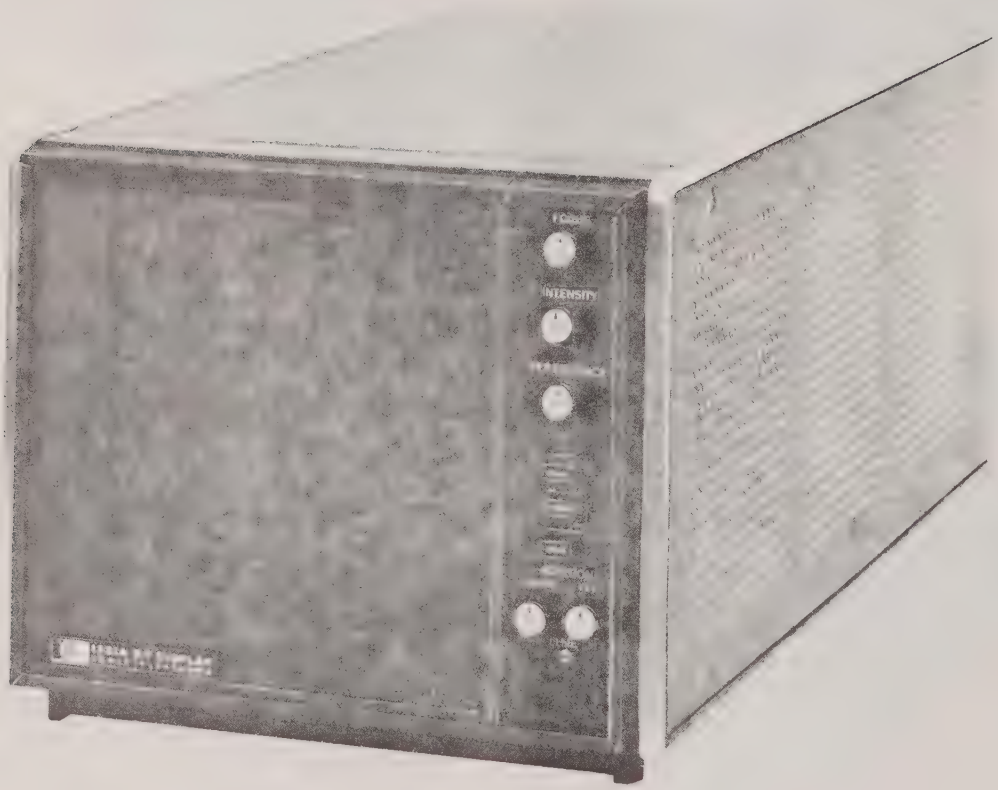


Figure 1-1. Model 1331A X-Y Display

SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This manual provides operating and servicing information for the Hewlett-Packard Model 1331A X-Y Display (figure 1-1). The manual is divided into eight sections, each covering a specific topic or aspect of the instrument. Schematics are located at the rear of the manual in Section VIII.

1-3. This section contains a description of Model 1331A. Table 1-3 lists and describes abbreviations used throughout the manual except in Section VI. The parts list in Section VI is a computer printout and uses computer-supplied abbreviations.

1-4. DESCRIPTION.

1-5. The following paragraphs provide a brief description of the instrument. Complete specifications are listed in table 1-1.

1-6. APPLICATIONS. The instrument is used in applications such as computer graphics and alphanumerics, nuclear spectrometry, spectrum and network analysis, swept-frequency measurements, nuclear and ultrasound medicine, frequency ratios, phase-shift measurements, raster presentations, and amplitude versus time displays.

1-7. CHARACTERISTICS. This instrument has front-panel controls for adjustment of focus, intensity, persistence, and position. Pushbutton switches are used to select the functional modes of write, store, or erase.

1-8. Variable persistence permits adjustment of display retention to match changing characteristics of input signals. Flicker is eliminated by increasing the persistence. Complete waveforms of electromechanical, biomedical, chemical, oceanographic, geological, and many other signals can be viewed. Z-axis information is displayed in the form of stored shades of gray. An input z-axis signal of +1V will override any intensity setting and turn beam intensity fully on. Similarly, a —1V signal overrides any intensity setting and turns the beam off. In-between voltages cause information to be displayed in various shades of gray.

1-9. CATHODE-RAY TUBE. The instrument uses a post-accelerator storage CRT with a 10.5-kV accelerating potential and aluminized P31 phosphor. The 10.5-kV accelerating potential is achieved with a post-accelerator voltage of +7.5 kV and a write gun cathode voltage of —3 kV. The CRT is capable of operating in a variable persistence storage mode. The mesh-type storage eliminates the need for refreshing the display. The 8 x 10 division internal graticule is located on the same plane as the phosphor to eliminate parallax.

1-10. OPTIONS. Standard options available with Model 1331A are listed in Section VII. Additionally, Hewlett-Packard provides an engineering service for adapting instruments to special customer specifications. Refer to Section VII and contact the nearest Hewlett-Packard Sales/Service Office (addresses in in rear of this manual).

1-11. ACCESSORIES. Accessories available for use with Model 1331A are listed in table 1-2. Hewlett-Packard has a wide range of test equipment and accessories available for use with Hewlett-Packard instruments or instruments of other manufacturers. Refer to the latest Hewlett-Packard catalog or contact the nearest Hewlett-Packard Sales/Service Office (address in rear of this manual).

1-12. WARRANTY.

1-13. Model 1331A is certified and warranted as stated in the front of this manual. The CRT is covered by a separate warranty located in the rear of the manual. Instructions for filing a warranty claim and a warranty claim form are included on the tear-out warranty page.

CAUTION

Instrument warranty may be void if serial number tag is missing or mutilated.

1-14. INSTRUMENT AND MANUAL IDENTIFICATION.

1-15. This manual applies directly to instruments with a serial prefix as listed on the title page. The prefix is the first group of digits in the instrument serial number (see figure 1-2).

1-16. Check the serial prefix. If it is different from the one listed on the title page, refer to Section VII for instructions to adapt this manual for proper instrument coverage.

1-17. Errors in this manual are corrected under errata on an enclosed manual changes sheet (if any).

Table 1-1. Specifications

VERTICAL AND HORIZONTAL AMPLIFIERS

BANDWIDTH: dc to 1 MHz (3 dB down at 1 MHz).

PHASE SHIFT: <1° to 0.5 MHz.

SETTLING TIME: Signal settles to within 1 spot diameter of final value in <1 us, for any on-screen movement.

DEFLECTION FACTOR:

Vertical: 1 V for 8 div deflection. Internally adjustable from 0.09 V/div to 0.14 V/div.

Horizontal: 1V for 10 div deflection. Internally adjustable from 0.09 V/div to 0.14 V/div. Printed circuit board mounting pads are provided for installation of attenuators to x- and y-inputs if a larger full-screen deflection voltage is required.

COMMON MODE REJECTION RATIO: 40 dB to 10 kHz for differential input of 3 V maximum between outer-and inner-coaxial input leads.

INPUT: Both amplifiers are differential. Cable shield and center conductor from input BNC connector connect to amplifier input channels. Input circuitry can be modified so that amplifier operation is fully differential and balanced, completely single-ended, reflects a lower input termination impedance, or presents a different deflection factor (refer to Section III). Polarity is reversible.

INPUT RC

Driven Side (Center Conductor): 100 kilohms shunted by approximately 80 pF to ground.

Shield Side: 47 ohms to ground (may be replaced with 100 kilohms for differential operation).

Circuit board mounting pads are provided for installation of a termination resistor between center conductor and shield.

MAXIMUM INPUT: ±50V (dc + pk ac).

Z-AXIS AMPLIFIER

BANDWIDTH: dc to 5 MHz; rise time approx 70 ns.

INPUT RC

Single-ended: 10 kilohms shunted by approx 60 pF to ground.

Differential: 20 kilohms shunted by approx 60 pF.

INPUT: —1V blanks spot of any intensity; +1V provides maximum intensity. Mounting pads are provided on the circuit board for addition of attenuation resistor in series with the input to increase blanking signal amplitude.

MAXIMUM INPUT: ±10V (dc + pk ac).

CATHODE-RAY TUBE AND CONTROLS

TYPE: Post-accelerator storage tube, approx 10.5-kV accelerating potential, aluminized P31 phosphor.

GRATICULE: 8 x 10 div internal graticule. 1 div = 0.95 cm. 0.2-div subdivisions marked on major axes.

BEAM FINDER: Returns beam to screen regardless of setting of HORIZ and VERT POSITION controls. Rear-panel switch.

STORAGE PARAMETERS: See table below.

Parameter	Variable Persistence Mode
Writing speed	>20 div/ms
Dot writing time	<4 us
Information storage rate	>200 kdots per sec
Store time	Writing mode, 1 minute min. Store mode, 15 minutes min. (Store time during store mode may be internally adjusted to be greater than 15 minutes at the expense of stored trace brightness) Min persistence, 0.25 sec min.
Brightness	>100 fL in write mode
Erase time	≈500 ms

Note: Specifications on storage parameters apply only over a 7 x 9 division area centered on CRT.

SAFETY

Listed and labeled by Underwriters Laboratories under standard 544 (Medical and Dental Equipment).

Designed and manufactured in accordance with IEC 348 International Safety Standard for Electronic Measuring Equipment.

Conforms to all OSHA requirements.

GENERAL

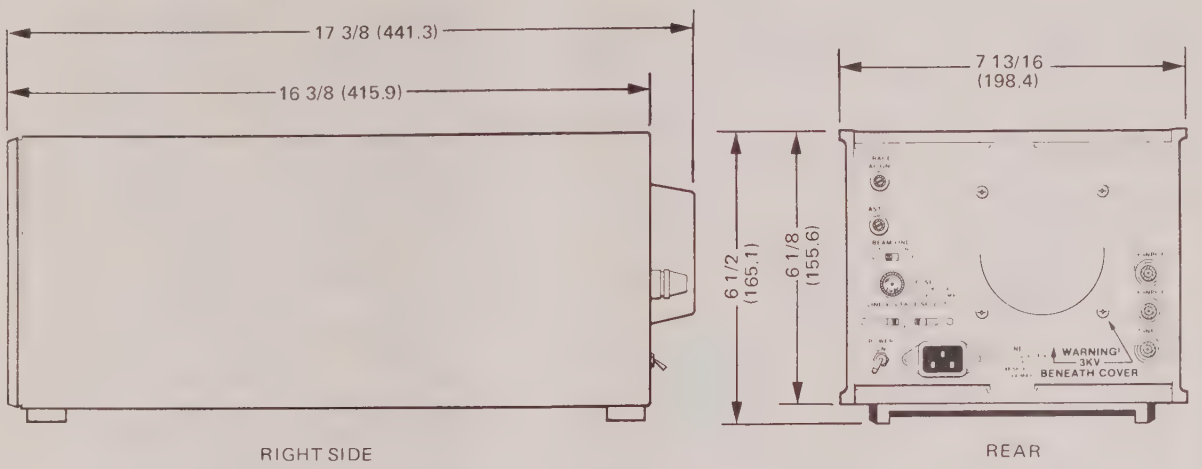
INPUT CONNECTORS

X-, Y-, Z-inputs: Rear-panel floating BNC connectors.

Table 1-1. Specifications (Cont'd)

POWER: 100, 120, 220, or 240V, +7.5%, 48 to 66 Hz, 150 VA max.
WEIGHT: Net, 19 1/2 lb (8.85 kg); shipping, 25 lb (11.34 kg).
DIMENSIONS: Refer to outline drawing.
OPTIONS: Refer to Section VII.

NOTE:
DIMENSIONS IN INCHES AND (MILLIMETERS)



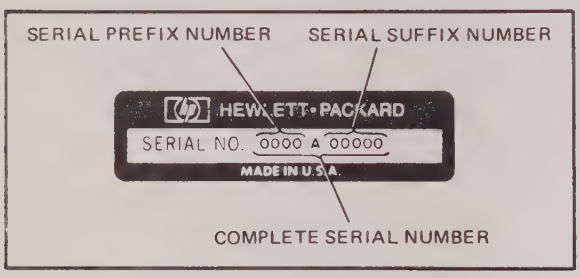


Figure 1-2. Instrument Serial Number

1-18. INQUIRIES.

1-19. Refer any questions regarding Model 1331A, this manual, or the change sheet to the nearest Hewlett-Packard Sales/Service Office. Always include the model number, complete name, and complete serial number in all correspondence. A world-wide listing of Hewlett-Packard Sales/Service Office is provided in the rear of this manual.

Table 1-2. Accessories Available

CAMERA ADAPTER: Model 10366B adapter provides for mounting of a HP Model 197A, or 198A camera.
DISPLAY CABLE, MODEL 10488A: Provides interconnection between the display and signal input source. The cable contains three color-coded coaxial cables with three male BNC connectors on each end for X-, Y-, and Z-inputs. Length is approx 12 ft (3.6m).
FRAME ADAPTER, HP Part Number 5060-8762: A 7-inch (18 cm) high panel allows two Model 1331A's to be mounted side-by-side in a standard 19 inch (48 cm) rack.
FILTER PANEL, HP Part Number 5060-8760: Covers half of a frame adapter when only one Model 1331A is in a frame adapter.

Table 1-3. Reference Designations and Abbreviations

REFERENCE DESIGNATIONS

A	ASSEMBLY	E	MISC. ELECTRICAL PART	P	PLUG	U	INTEGRATED CIRCUIT (UNREPAIRABLE)
AT	ATTENUATOR RESISTIVE TERMINATION	F	FUSE	PS	POWER SUPPLY	V	VACUUM TUBE, NEON BULB, PHOTOCELL, ETC.
B	MOTOR, FAN	FL	FILTER	Q	TRANSISTOR	VR	VOLTAGE REGULATOR (DIODE)
BT	BATTERY	H	HARDWARE	R	RESISTOR	W	CABLE
C	CAPACITOR	J	JACK	RT	THERMISTOR	X	SOCKET
CP	COUPLING	K	RELAY	S	SWITCH	Y	CRYSTAL
CR	DIODE	L	INDUCTOR	T	TRANSFORMER	Z	NETWORK
DL	DELAY LINE	LS	SPEAKER	TB	TERMINAL BOARD		
DS	DEVICE SIGNALING (LAMP)	M	METER	TP	TEST POINT		
		MP	MECHANICAL PART				

ABBREVIATIONS

A	AMPERE(S)	F	FARAD(S)	n	NANO (10^{-9})	rfi	RADIO FREQUENCY INTERFERENCE
At	AMPERE TURN(S)	FET	FIELD-EFFECT TRANSISTOR(S)	nc	NORMALLY CLOSED	rms	ROOT MEAN SQUARE
ampl	AMPLIFIER(S)	G	GIGA (10^{9})	no.	NORMALLY OPEN	rwv	REVERSE WORKING VOLTAGE
assy	ASSEMBLY	gnd	GROUND(ED)	npn	NEGATIVE-POSITIVE-NEGATIVE	SCR	SILICON CONTROLLED RECTIFIER
ampltd	AMPLITUDE			ns	NANOSECOND	sec	SECOND(S)
bd	BOARD(S)	H	HENRY(IES)	p	PICO (10^{-12})	std	STANDARD
bp	BANDPASS	hr	HOUR(S)	pc	PRINTED (ETCHED) CIRCUIT(S)	trmr	TRIMMER
c	CENTI (10^{-2})	HP	HEWLETT-PACKARD	pk	PEAK	u	MICRO (10^{-6})
C	CARBON	Hz	HERTZ	pnp	POSITIVE-NEGATIVE-POSITIVE	usec	MICROSECOND
ccw	COUNTERCLOCKWISE	if.	INTERMEDIATE FREQ.	p/o	PART OF	V	VOLTS
coax.	COAXIAL	intl	INTERNAL	p-p	PEAK-TO-PEAK	var	VARIABLE
coef	COEFFICIENT	k	KILO (10^{3})	prgm	PROGRAM	w/	WITH
com	COMMON	lb	POUND(S)	prv	PEAK INVERSE VOLTAGE(S)	w/o	WITHOUT
CRT	CATHODE-RAY TUBE	lpf	LOW-PASS FILTER(S)	ps	PICOSECOND	wiv	WORKING INVERSE VOLTAGE
cw	CLOCKWISE	m	MILLI (10^{-3})	pwv	PEAK WORKING VOLTAGE		
d	DECI (10^{-1})	M	MEGA (10^{6})	rf	RADIO FREQUENCY		
dB	DECIBEL	ms	MILLISECOND				
ext	EXTERNAL						

SECTION II

INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains instructions for preparing the Model 1331A for operation and for performing an initial inspection. The procedures for making a claim for warranty repairs and for repacking the instrument for shipment are also contained in this section.

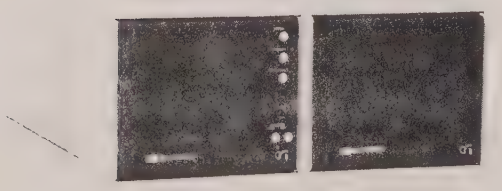
WARNING

Read the Safety Summary in the front of this manual before installing or operating the Model 1331A.

2-3. PREPARATION FOR USE.

2-4. The following paragraphs discuss facts that should be known by the operator before operation of the instrument.

2-5. RACK MOUNTING. Figure 2-1 shows how one or two instruments can be mounted in a single rack adapter. If only one instrument is to be rack mounted, the extra hole can be closed with a filler panel. Refer to Section I for ordering information on the rack adapter and filler panel.



1331A-A-5

Table 2-1. Shipping Carton Test Strength

2-6. POWER CORD. The power cord required depends on, (1) the ac input voltage, and (2) the country in which the instrument is to be used. Figure 2-2 illustrates the standard power receptable (wall outlet) configurations that are used throughout the United States and in other countries. The HP part number shown adjacent to each receptable drawing is the part number for a power cord equipped with a mating plug for that receptable. If the appropriate power cord is not included with the instrument, notify the nearest Hewlett-Packard Sales/Service Office and a replacement cord will be provided.

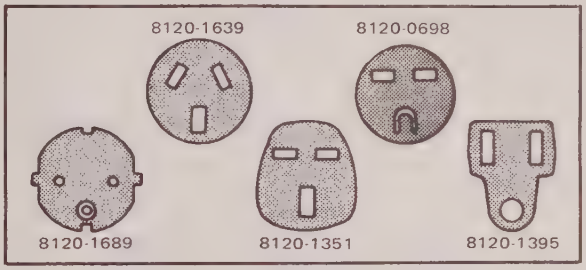


Figure 2-2. Power Receptacles

2-7. POWER REQUIREMENTS. Model 1331A requires one of the following power sources: 100, 120, 220, 240 Vac +7.5% —10%, 48 to 66 Hz. The instrument is normally shipped from the factory set to operate at 120 Vac as shown in figure 2-3A. To set operation for a different line voltage proceed as follows:

a. Disconnect power cord (if connected).

b. Determine switch positions required for power source selected.

c. Slide left and right switches to required positions. For example, if 220V operation is desired slide left switch to left and right switch to right (figure 2-3B) from positions shown in figure 2-3A for 120V operation.

d. Install appropriate fuse in the fuse holder on rear panel. Correct fuse size is indicated adjacent to fuse holder.

e. Connect applicable power cord.

2-8. INSTRUMENT COOLING. The instrument is adequately cooled by normal air circulation. A 2-inch clearance is required at sides and top and 5/8 inch at bottom when mounted singly (figure 2-4A). When mounted in this configuration, the maximum ambient temperature must not exceed +55 deg C.

2-9. When mounted in pairs, the minimum clearances shown in figure 2-4B, must be provided. When mounted in this configuration, the surface directly beneath the instrument(s) must not be a heat source and the maximum ambient temperature must not exceed +45 deg C.

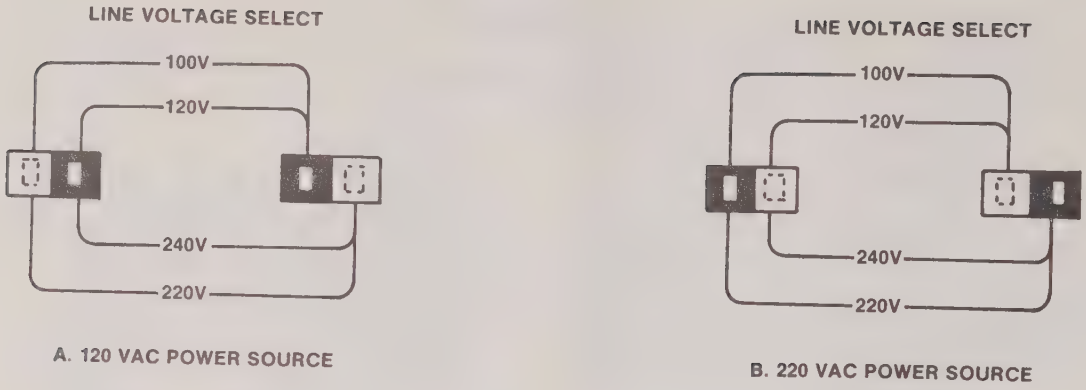


Figure 2-3. Line Voltage Selection

2-10. The clearances indicated in figure 2-4 will provide adequate ventilation if air is allowed to circulate freely across all surfaces and the specified maximum ambient temperatures are not exceeded. Other mounting configurations and environments may require additional cooling measures.

2-11. INPUTS. Input signals to be displayed are connected to the X-, Y-, and Z-axis amplifiers through BNC connectors on the rear panel. Refer to table 1-2 for information on a recommended display cable. The impedance of signal sources must be 20 kilohms or less. The impedance from the BNC shield to ground must be less than 1 kilohm. Inputs not in use should be shorted. This can be done with a BNC shorting plug (HP Part No. 1250-0774).

2-12. INITIAL INSPECTION.

2-13. The instrument was inspected electrically and mechanically before shipment. Upon receipt, inspect it for damage that may have occurred in transit. Accomplish the performance checks in Section V. Retain the packing material for reshipment of the instrument.

2-14. CLAIMS.

2-15. The warranty statement applicable to this instrument is printed in the front of this manual. The CRT warranty and claims form is located on a tear-out page in the rear of the manual. If damage is found, or if performance is not as specified, notify the carrier and the Hewlett-Packard Sales/Service Office immediately. Refer to the back of this manual for addresses. The Hewlett-Packard Sales/Service Office will arrange for repair or replacement without waiting for settlement of a claim with the carrier.

2-16. REPACKING FOR SHIPMENT.

2-17. If the instrument is to be shipped to a Hewlett-Packard Sales/Service Office for service or repair, attach a tag showing owner (with address), instrument serial number, and a description of the service required.

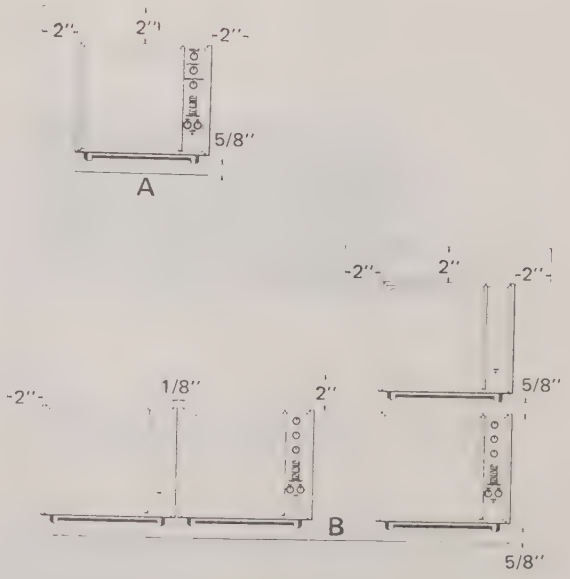


Figure 2-4. Ventilation Tolerances

2-18. Use the original shipping carton and packing material, if available. If not available, the Hewlett-Packard Sales/Service Office will provide information and recommendations on material to be used. Material for shipping an instrument normally include the following:

a. A double-walled carton. Refer to table 2-1.

b. Heavy paper or sheets of cardboard to protect all instrument surfaces; use a nonabrasive material such as Kimpack all around projecting parts.

c. At least 4 inches of tightly-packed, industry-approved, shock-absorbing material such as extra-firm polyurethane foam.

Table 2-1. Shipping Carton Test Strength

Gross Weight (lb)	Carton Test Strength (lb)
up to 10	200
10 to 30	275
30 to 120	350
120 to 140	500
140 to 160	600

SECTION III

OPERATION

3-1. INTRODUCTION.

3-2. This section contains an explanation of Model 1331A operating controls and connectors, general operating procedures, multiple display information, preoperational checkout procedure, operator maintenance, and instructions for simple modification of amplifier input circuitry to obtain additional instrument adaptability and versatility.

3-3. OPERATION.

3-4. CONTROLS AND CONNECTORS. Operating controls and connectors are located on both front and rear panels. Figure 3-1 provides a brief description of controls, connectors, indicators, and contrast screen. Controls requiring further explanation are covered in the following paragraphs.

3-5. The INTENSITY control adjusts the write-beam intensity from completely off to maximum brightness. The intensity setting should always be maintained at a point below where dot or trace blooming occurs. Write-beam electrons striking the storage surface cause a rapid increase in potential. Energy from this sudden change is converted to heat. When this heat exceeds the heat-dissipation rating of the storage surface, it burns the dielectric. The burning is visible as dot or trace blooming.

3-6. Before connecting power cord, the two LINE VOLTAGE SELECT switches must be positioned correctly for the line voltage to be applied (100V, 120V, 220V, or 240 Vac). Check FUSE to assure usage of properly rated fuse. (See voltage-fuse requirements stated adjacent to fuse holder).

3-7. Setting the BEAM FIND switch to ON reduces gain of the vertical and horizontal amplifiers sufficiently to return beam to viewing area. This enables the operator to locate the beam and determine action necessary to center a display; examples: reduce input-signal amplitude, adjust deflection factor, or adjust POSITION controls. When centered properly, the beam will remain on the CRT when the switch is returned to OFF. Always return BEAM FIND to OFF position because the instrument will not operate properly when it is set to ON. Prior to BEAM FIND activation, set INTENSITY fully ccw. Set BEAM FIND to ON and turn INTENSITY slowly cw until dot or trace becomes visible.

3-8. FOCUS and ASTIG (astigmatism) controls are used to obtain a sharp display. Normally the ASTIG control need not be adjusted once it is set.

3-9. PREOPERATIONAL CHECKOUT PROCEDURE. The preoperational checkout procedure should be performed periodically to verify functional operation of the instrument (see figure 3-2).

3-10. OPERATOR'S MAINTENANCE. Operator's maintenance should be limited to the preoperational checkout and exterior cleaning of the instrument. Pull upward on the contrast screen for removal and cleaning; this exposes the CRT bezel and the protective shield. Remove four screws from CRT bezel and lift off bezel and shield to expose the face of the CRT for cleaning. The contrast screen, protective shield, and CRT face may be cleaned with alcohol and a soft, lintless cloth or tissue.

CAUTION

Some commercial cleaning tissues contain glass fibers which can scratch plastic surfaces.

3-11. Smooth metal surfaces may be cleaned with a household glass cleaner or a mild, liquid, household detergent. Corrosion should be removed with a fine abrasive. The sanded area should then be sprayed with GE DRI-FILM 88 or other suitable silicon resin.

3-12. GENERAL OPERATING PROCEDURES AND MULTIPLE DISPLAY INFORMATION. Figure 3-3 provides general operating procedures and multiple display information. The operations of WRITE, STORE, ERASE, and Multiple Display can be sequenced in various ways to meet a wide variety of operating requirements.

3-13. APPLICATION.

3-14. A list of suggested applications for the Model 1331A is provided in Section I of this manual. The instrument can be used for any application of x- y-, and z-axis displays within bandwidth and sensitivity specifications as stated in Section I. Additional adaptability and versatility may be obtained through simple reconfiguration of the x-, y-, and z-amplifier input circuitry to meet specific applications. The following discussion will clarify aspects concerning reconfiguration of amplifier input circuitry.

3-15. DIFFERENTIAL AMPLIFIERS. The x-, y-, and z-amplifiers are differential by design, and each has two input channels. An input signal to be displayed

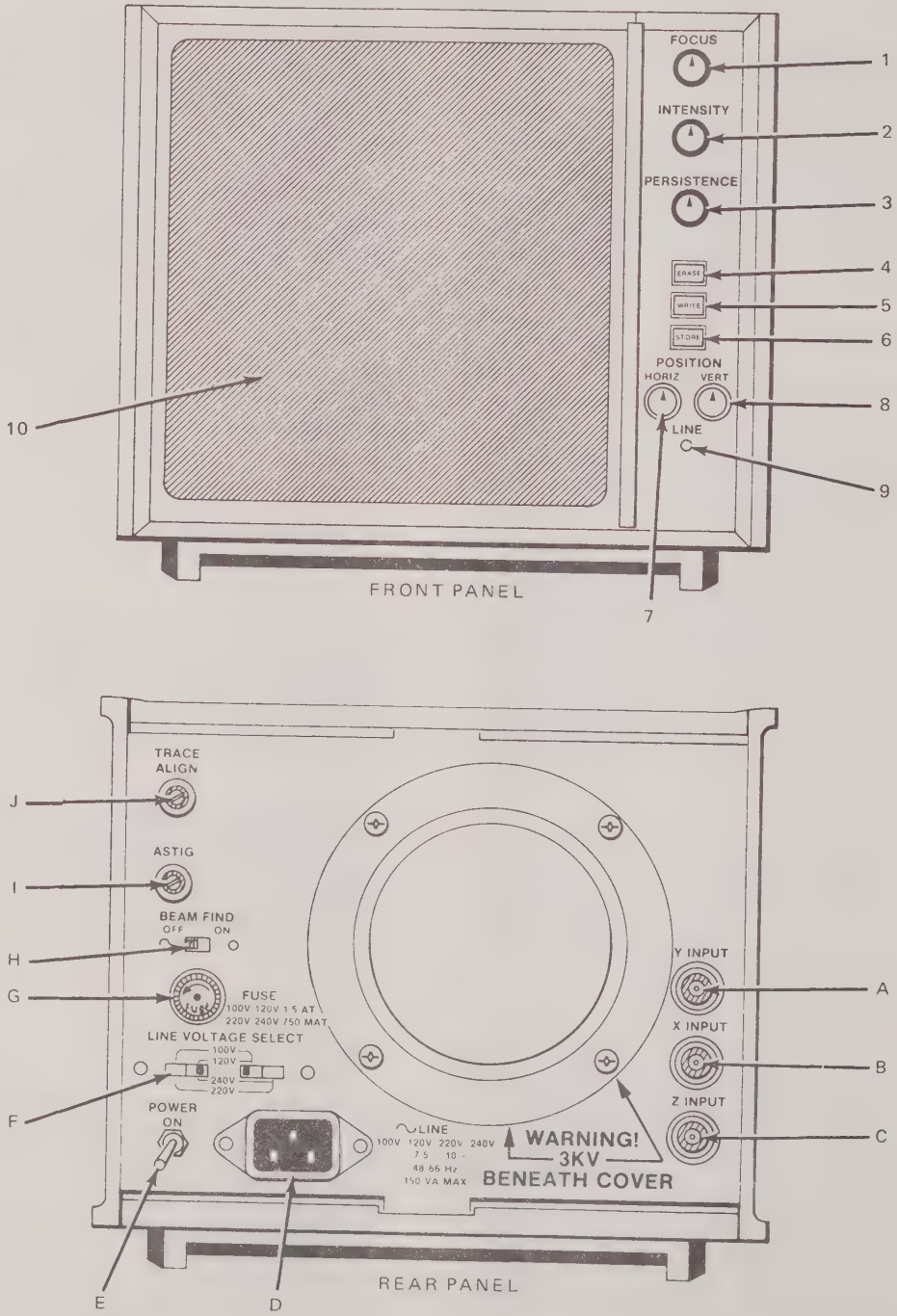


Figure 3-1. Controls, Connectors, Indicators, and Contrast Screen (Sheet 1 of 2)

FRONT PANEL

1. FOCUS. Adjusts sharpness of trace. Refer to paragraph 3-8.
2. INTENSITY. Adjusts brightness of trace. Refer to paragraph 3-5.
3. PERSISTENCE. Adjusts duration of trace in write mode.
4. ERASE. Press and release to remove display from CRT. Operates in write mode only.
5. Press to display input information on CRT (write mode).
6. STORE. Press in to store information for an extended time on CRT (store mode).
7. HORIZ POSITION. Adjusts vertical position of trace.
8. VERT POSITION. Adjusts vertical position of trace.
9. LINE indicator. Lights when operating power is applied to instrument.
10. CONTRAST SCREEN. Shields CRT display to increase contrast of trace.

REAR PANEL

A. Y INPUT. Input connector for y-amplifier.

B. X INPUT. Input connector for x-amplifier.

C. Z INPUT. Input connector for z-amplifier.

D. ~ LINE. Connects instrument to operating power.

E. POWER. Applies operating power to instrument.

F. LINE VOLTAGE SELECT. Connects power transformer for 100, 120, 220, or 240 Vac operation. Refer to paragraph 3-6.

G. FUSE. Protects instrument from current over-loads. Use recommended fuse for line voltage selected.

H. BEAM FIND. Brings off-screen trace back into viewing area. Refer to paragraph 3-7.

I. ASTIG. Adjusts trace-dot symmetry. Refer to paragraph 3-8.

J. TRACE ALIGN. Aligns trace with horizontal graticule.

Figure 3-1. Controls, Connectors, Indicators, and Constrast Screen (Sheet 2 of 2)

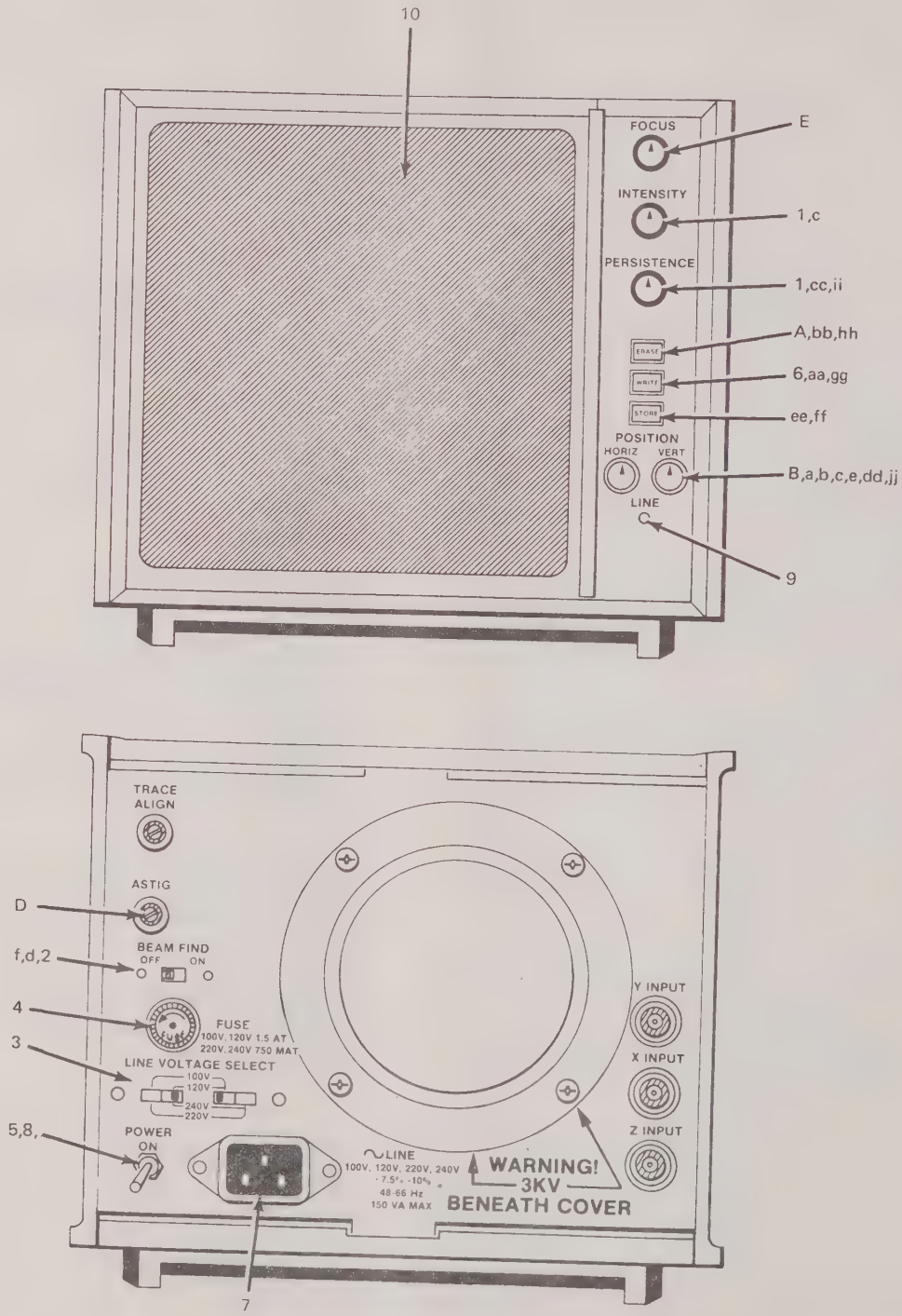


Figure 3-2. Preoperational Checkout Procedure (Sheet 1 of 4).

WARNING

Before attempting to operate this instrument, read the safety summary located at the front of this manual.

INITIAL CHECKOUT

1. Set INTENSITY and PERSISTENCE fully ccw.
2. Verify BEAM FIND switch to OFF.
3. Set LINE VOLTAGE SELECT switches to proper setting, (100, 120, 220, or 240 Vac).
4. Verify FUSE has proper rate for line voltage selected, (voltage-fuse requirements stated adjacent to fuse holder).
5. Set POWER switch to off position.
6. Press WRITE pushbutton.
7. Connect appropriate power cord to ~ LINE connector.
8. Apply power to instrument by placing POWER switch to ON.
9. Verify that LINE indicator lights.
10. Verify that green background appears on CRT within three minutes.

CAUTION

If green background does not appear on CRT within three minutes, set POWER switch to off and refer to troubleshooting procedures in Section VIII.

DOT SYMMETRY AND SIZE

A. Press and release ERASE pushbutton.

B. Center HORIZ and VERT POSITION controls.

CAUTION

Do not allow dot or trace to bloom during next step or thereafter.

C. Slowly turn INTENSITY cw until dot appears in viewing area and reaches acceptable viewing brightness.

D. Adjust ASTIG for best dot symmetry (roundness).

E. Adjust FOCUS for smallest dot size.

BEAM FIND

a. Adjust HORIZ POSITION over full range. Dot should move horizontally beyond the viewing area on each side.

b. Adjust VERT POSITION over full range. Dot should move vertically beyond the viewing area at top and bottom.

c. Set HORIZ and VERT POSITION controls fully ccw.

d. Set BEAM FIND to on. Dot should reappear within the viewing area.

e. Adjust HORIZ and VERT POSITION controls to center dot on CRT.

f. Set BEAM FIND to OFF.

TRACE PATTERN

aa. Press WRITE pushbutton.

bb. Press and release ERASE pushbutton.

cc. Turn PERSISTENCE fully cw.

dd. Generate random trace pattern by rotating the HORIZ and VERT POSITION controls. Observe that trace remains visible for >60 seconds.

ee. Press STORE pushbutton. Observe that intensity declines, and that further random rotation of HORIZ and VERT controls will not cause writing on CRT.

ff. Press ERASE pushbutton. Observe that displated information is not affected.

gg. Press WRITE pushbutton.

hh. Press and release ERASE pushbutton.

ii. Turn PERSISTENCE fully ccw.

jj. Adjust HORIZ and VERT POSITION controls to center dot on CRT.

Figure 3-2. Preoperational Checkout Procedure (Sheet 2 of 4)

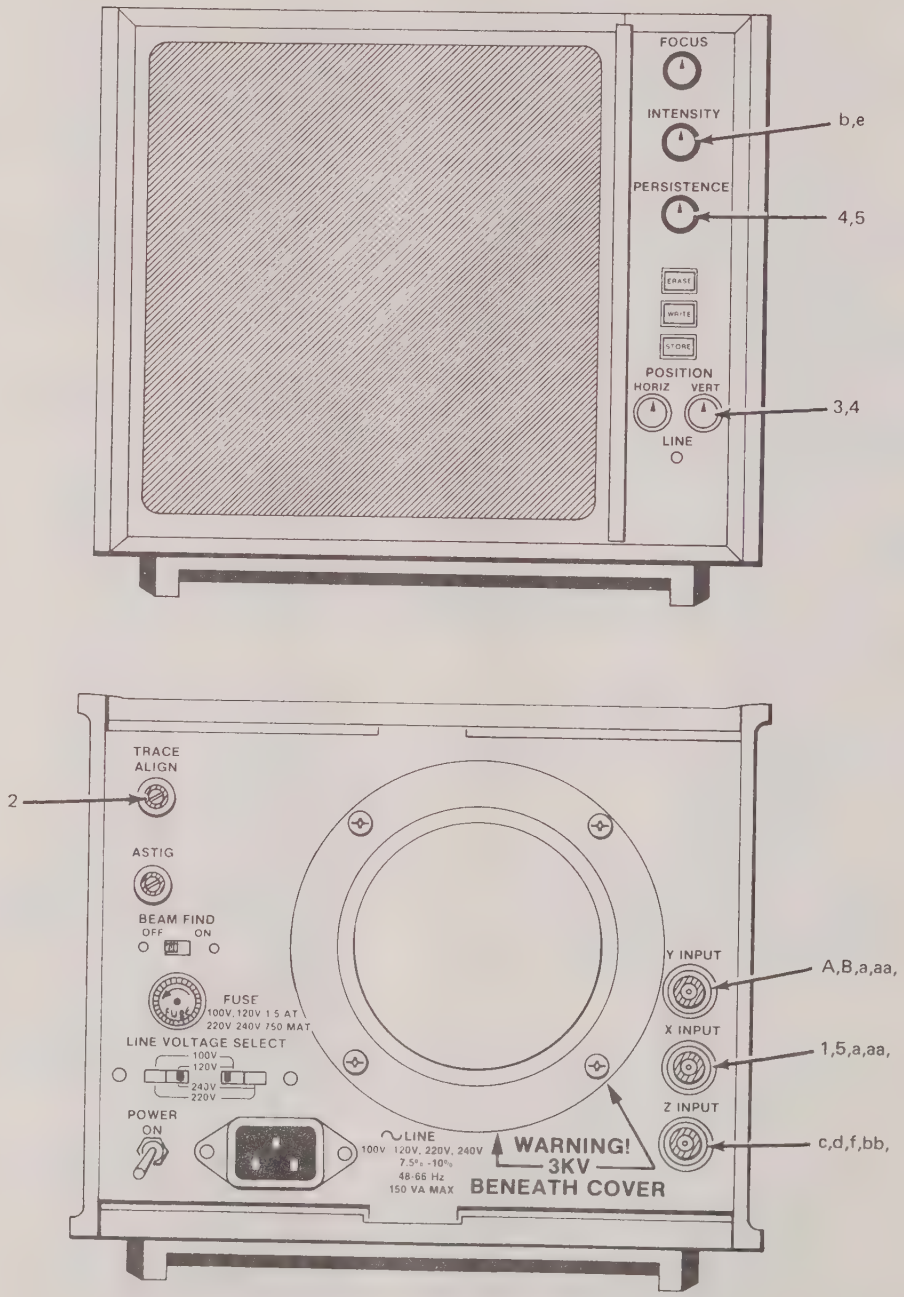


Figure 3-2. Preoperational Checkout Procedure (Sheet 3 of 4)

HORIZONTAL TRACE

1. Apply 1 kHz, 1V p-p signal to X INPUT. Horizontal trace should appear on CRT.
2. Adjust TRACE ALIGN until trace is parallel with horizontal graticule lines.
3. Rotate VERT POSITION control to move trace to different vertical levels. Observe that previous trace levels quickly disappear.
4. Turn PERSISTENCE fully cw and again rotate VERT POSITION. Observe that trace fades very slowly.
5. Turn PERSISTENCE fully ccw, and remove signal from X INPUT.

VERTICAL TRACE

A. Apply 1 kHz, 1V p-p signal to Y INPUT. Vertical trace should appear on CRT.

B. Remove signal from Y INPUT.

INTENSITY OVERRIDE

a. Apply 1 kHz, 1V p-p signal to both X INPUT and Y INPUT. Observe that a diagonal trace appears.

b. Adjust INTENSITY for desired brightness.

c. Apply —1V dc to Z INPUT. Observe that trace disappears.

d. Remove —1V dc signal from Z INPUT.

e. Turn INTENSITY fully ccw to extinguish diagonal trace.

f. Apply +1V dc to Z INPUT. Observe that +1V dc signal turns beam on.

DOT WRITING

aa. Using two ramp generators, apply different signals, each with amplitude equal to 1V p-p, to X INPUT and Y INPUT.

bb. Using a pulse generator, apply a signal to Z INPUT. Characteristics of the signal should be as follows: repetition rate =100 Hz; pulse width = 4 us; pulse amplitude = 1V; pulse polarity to be positive. Observe that each time the pulse generator turns on, a dot results.

Figure 3-2. Preoperational Checkout Procedure (Sheet 4 of 4)

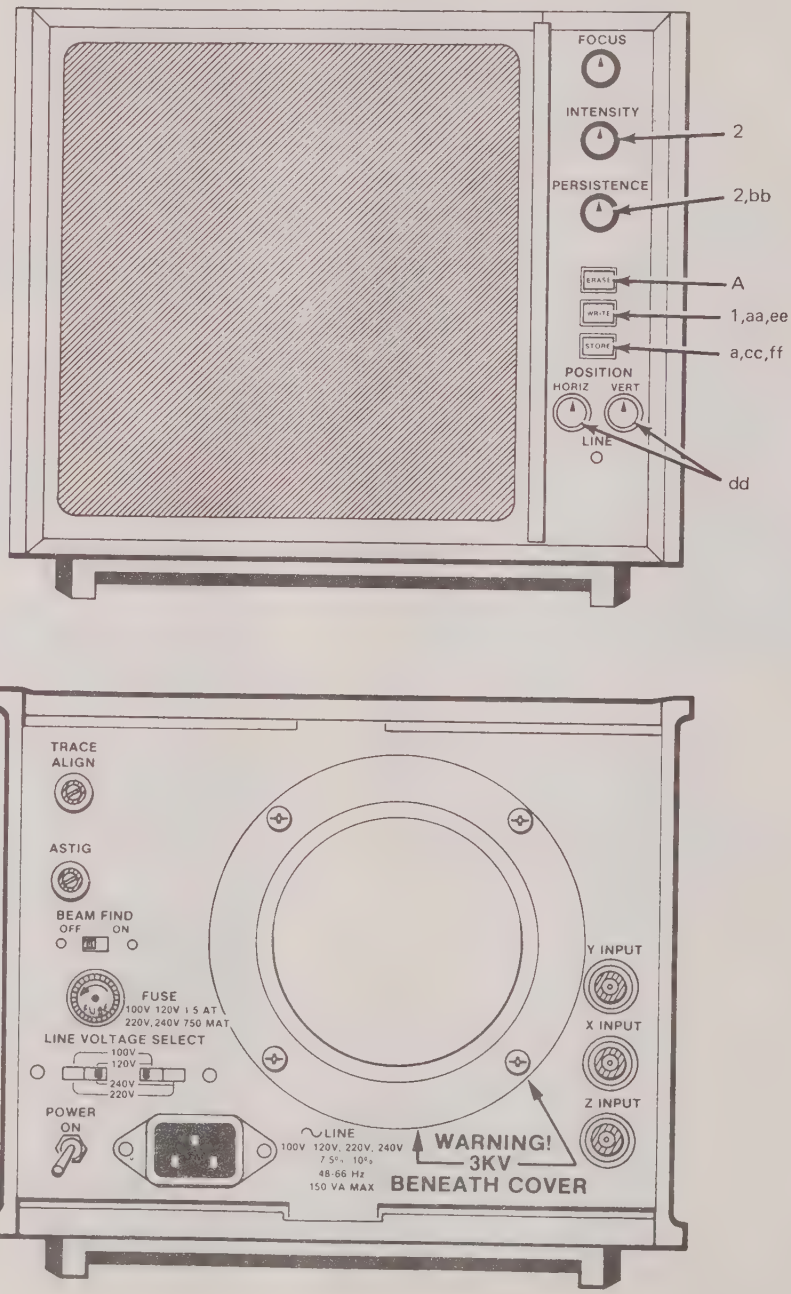


Figure 3-3. General Operating Procedures and Multiple Display Information (Sheet 1 of 2)

WARNING

Before attempting to operate this instrument, read the safety summary located at the front of this manual.

WRITE

1. Press WRITE pushbutton.
2. Adjust INTENSITY and PERSISTENCE controls for desired brightness and duration of display. Adjust INTENSITY as required to avoid dot or trace blooming.

ERASE

A. Press and release ERASE pushbutton.

NOTE

This operation is valid in write mode only; therefore, the WRITE pushbutton must be pressed before the ERASE pushbutton. Erasure should take place prior to writing each new piece of information, except when two or more pieces of information are to be displayed simultaneously (multiple display).

STORE

a. After desired information has been written, (WRITE pushbutton depressed), press STORE. Observe that WRITE pushbutton will release.

Multiple Display

aa. To generate first display, press WRITE pushbutton.

bb. Adjust PERSISTENCE fully cw.

cc. After desired information has been written, press STORE pushbutton.

dd. Adjust HORIZ and VERT POSITION controls to position trace so that new information will not interfere with information previously written. Try to keep write periods short because each write period reduces time that previous written information can be stored.

ee. To generate second display, press WRITE pushbutton.

ff. Press STORE pushbutton after desired information is written.

NOTE

This procedure may be repeated as many times as desired.

Figure 3-3. General Operating Procedures and Multiple Display Information (Sheet 2 of 2)

is connected from the rear-panel connector to the amplifier by coaxial cable with the shield and center conductor connected to the differential amplifiers input channels. Output signals of the x- and y-amplifiers drive the CRT horizontal- and vertical-deflection plates, while the z-amplifier signal is applied to an intensity gate which drives the CRT write-gun intensity grid.

3-16. SITUATIONS REQUIRING INPUT RECONFIGURATION. The amplifiers input-circuitry configuration required for a specific application relates many times to the balanced or unbalanced characteristics of the coaxial cable coupled to the amplifier input. For best common-mode rejection, input circuits connected to balanced sources, (twisted pair, shielded pair, twin lead, etc), should be configured for truly differential operation with both the center conductor and the shield amplifier channel balanced in impedance and sensitivity. Input circuits for coax are generally configured for either true, or compromise-type, single-ended operation. True single-ended operation is characterized by grounding the shield channel input, and compromise by connecting a low value of resistance between shield and ground. This is the configuration as shipped from the factory. The 47-ohm resistors between shield and ground provide some common-mode rejection capability and minimize ground-loop currents, while terminating interference currents picked up by the cable shield.

3-17. When coaxial cable is used, large transients currents may be generated in the cable shield through capacitive or inductive coupling with none, or very little, in the center conductor. This is especially true where long cables are used or where cable is routed near equipment generating large amounts of current. One method of reducing this type of interference is to ground the shield at the amplifier input, creating true single-ended operation. Sometimes, however, a ground loop may develope when the shield is directly grounded. For this case, a satisfactory compromise is accomplished by connecting a low resistance between shield and ground. This is the input configuration of the instrument as shipped from the factory. At other times, a common-mode rejection capability is needed to reject noise common to both the shield and the center conductor. For this case, both the amplifier input channels are configured identically to generate similar impedance and sensitivity characteristics. For fully differential operation, replace A1R4 and A1R34 with 100-kilohn resistors, (Hewlett-Packard Part No. 0757-0367).

3-18. In another application, a specific value of signal input termination resistence may be required. Input termination resistance of the x- and y-amplifiers is normally 100 kilohms, single-ended. The termination resistance can be changed by either of two methods: (1) changing channel attenuator resistors, or (2) shunting a resistor between center conductor and shield. The latter method is preferred because it is simple and doesn't affect the amplifier's full scale deflection factor associated with the CRT graticule display. Termination resistance of the z-amplifier is normally 10 kilohms, single-ended and 20 kilohms, differential. Pads are also provided on the circuit board for connecting a resistor directly from shield to center conductor on z inputs.

3-19. Magnitude of the input signal may require changing the amplifier attenuation factor to >1 volt, full screen. This may be accomplished by changing the attenuator resistors in the input circuits. As shipped from the factory, the x-, and y-, and z-amplifier attenuation factors are one. This establishes for the x, and y-amplifiers, respectively, full-scale deflection of 10 divisions horizontally and 8 divisions vertically on the CRT graticule for 1 volt p-p input. Deflection factors of both x- and y-amplifiers are internally adjustable from 0.09 V/div to 0.14 V/div. A+1 volt input to the z-amplifier will cause a change in the CRT beam current from cutoff to full brightness or vice-versa with a —1 volt input. In-between voltages cause z-axis information to be displayed in various shades of gray.

3-20. Normal trace movement for positive x- and y-amplifier inputs is to the right and up, respectively. If polarity inversion is required, this may be accomplished by interchanging two resistors (one in each of the amplifiers two input channels), and by switching the shield and center conductor leads.

3-21. X—, Y—, and Z-AMPLIFIER INPUT CONFIGURATIONS. The x-, y-, and z-amplifier input circuits may be reconfigured to adapt them for use in a wide variety of applications. Reconfiguration is acccomplished by adding, deleting, or changing the value of input components. Extra mounting pads have been provided on circuit boards to accommodate most of the added components. However, for some applications existing components must be removed to accommodate new ones. Figures 3-4 and 3-5 provide x-, y-, , z-input modification schematics and associated component-location illustrations for circuit board assemblies A1 and A2. Solid lines (not dashed-lined circuitry components RA, RB, RT, CC, CS, and jumper A) represent the input circuit configuration as shipped from the factory.

3-22. Factory Configuration. Normal configuration of the deflection amplifiers is quasi-single-ended, while the z-amplifier is fully differential and balanced (see figure 3-5).

3-23. True Single-Ended Configuration. The following changes are applicable to obtain ture single-ended operation for the deflection amplifier. Insert jumper A on the low (shield) side if true single-ended operation is required on high sides. Reverse if opposite effect is desired. Also, reverse input cable loads. (See figure 3-4, sheet 2 for mounting pad locations for jumper).

3-24. Differential and Balanced Common-Mode Configuration. The following changes are necessary to convert the x- and y-amplifier from single-ended configuration (as shipped from the factory) to the fully differential and balanced configuration for best common-mode rejection. X-Amplifier: Replace resistor A1R34 (47 ohms) with a resistor identical to A1R33 (100 kilohms). See figure 3-4, sheet 2 for component locations. Y-Amplifier: Replace resistor A1R4 (47 ohms) with a resistor identical to A1R3 (100 kilohms). See figure 3-5, sheet 2 for component locations. The Z-Amplifier requires no change, since it is shipped from the factory on the fully differential and balanced configuration for best common-mode rejection.

3-25. Lower Input-Termination Resistance. A simple method for lowering input-termination resistance of the amplifiers is to install the desired termination resistance across mounting pads provided, as shown by RT in figures 3-4 and 3-5. The method is simple, because only one component is involved, and the amplifier-attenuation factors do not become involved. When shunting a resistance across the amplifier input to lower the resistance, the main consideration is the desired resistance. If RT is less than 2.5 kilohms, the maximum input voltage to the amplifier must be reduced because of resistor power-dissipation limits.

3-26. Input-Attenuation Factor. As shipped from the factory, the voltage input for full-scale deflection (Vfds is 1 volt). That is, one volt at the input of the x-amplifier or y-amplifier causes 10 horizontal divisions or 8 vertical divisions of deflection on the CRT graticule. Table 3-1 lists the components required for four deflection-amplifier attenuation factors. Table 3-2 lists the components required for three z-amplifier attenuation factors. Table 3-3 lists descriptions of components and their Hewlett-Packard part numbers. Component modification locations on boards A1 and A2 are shown in figures 3-4 and 3-5.

If the deflection amplifiers (after modification) are to remain in the single-ended configuration, make only the changes stated for high side of the amplifier. If differential (balanced) operation is required, make changes stated for both high and low sides.

3-27. Resistor values for attenuation ratios not listed in tables 3-1 and 3-2 can be determined by the following formula:

$$Vfsd = \frac{RA + RB}{RB}$$

CAUTION

Spacing on the printed circuit board is for 1/2 watt, 1%, metal film resistors. If RA + RB is less than 5 kilohms, the maximum input voltage must be reduced because of resistor power-dissipation limits.

3-28. To select the values for compensating capacitors, use the following formula:

$$CS = \left(\frac{CC \bullet RB}{RB} \right) - 9 \text{ pF}$$

Select a variable capacitor for CC and use its mid-range value in the calculation.

3-29. Polarity Inversion. To achieve polarity inversion for amplifier-input circuits configured for fully balanced differential operation, the input cable connection is reversed at single-pin connectors on board A1 (see figure 3-4) for the deflection amplifiers, and on board A2 (figure 3-5) for the z-amplifier. If the deflection amplifiers are in the normal single-ended input cinfiguration, reverse R33 and R34 only for the x-amplifier, and R3 and R4 for the y-amplifier in addition to reversing input cable connections.

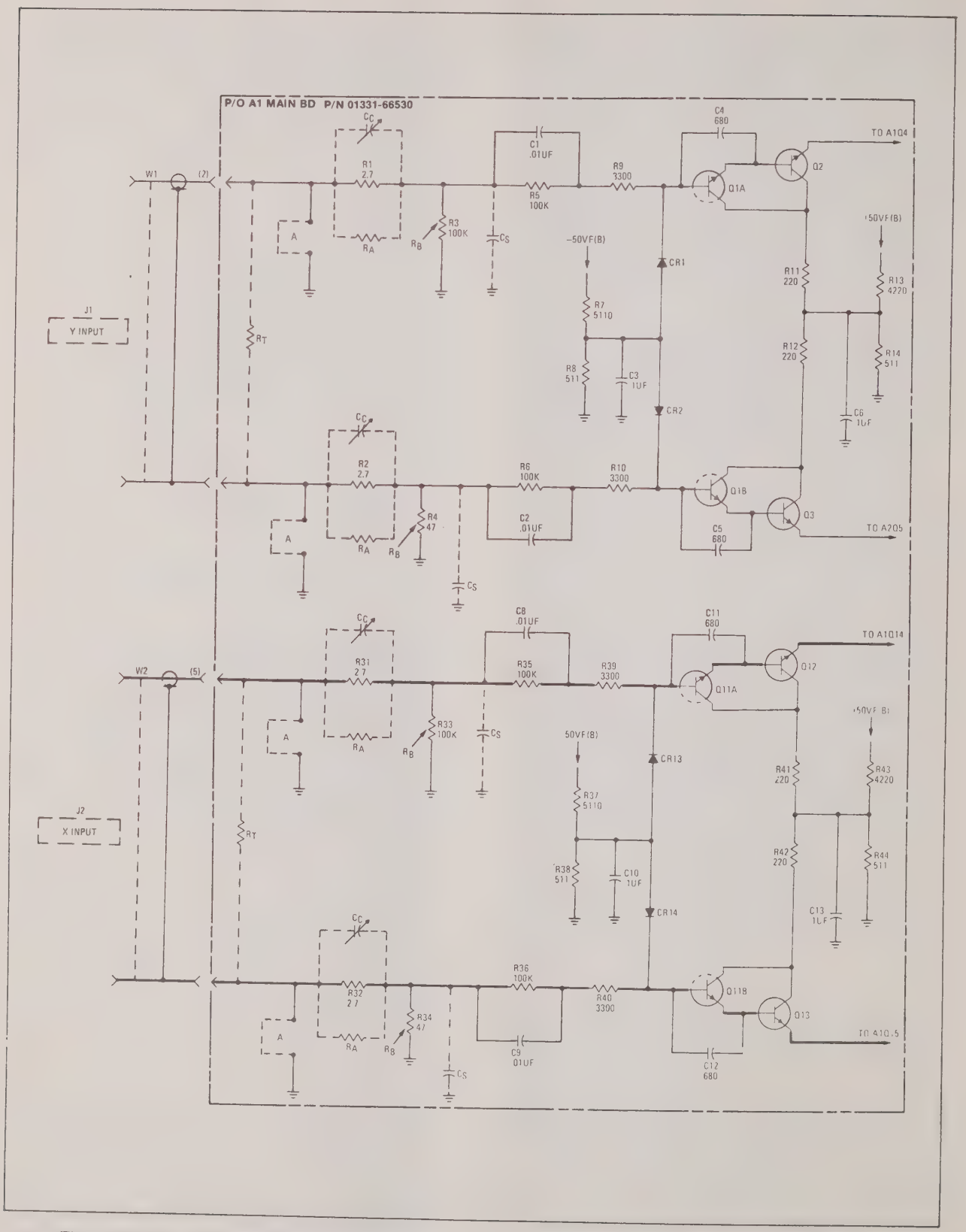


Figure 3-4. X- and Y-Amplifier Input Modification Schematic and Component Locations (Sheet 1 of 2)

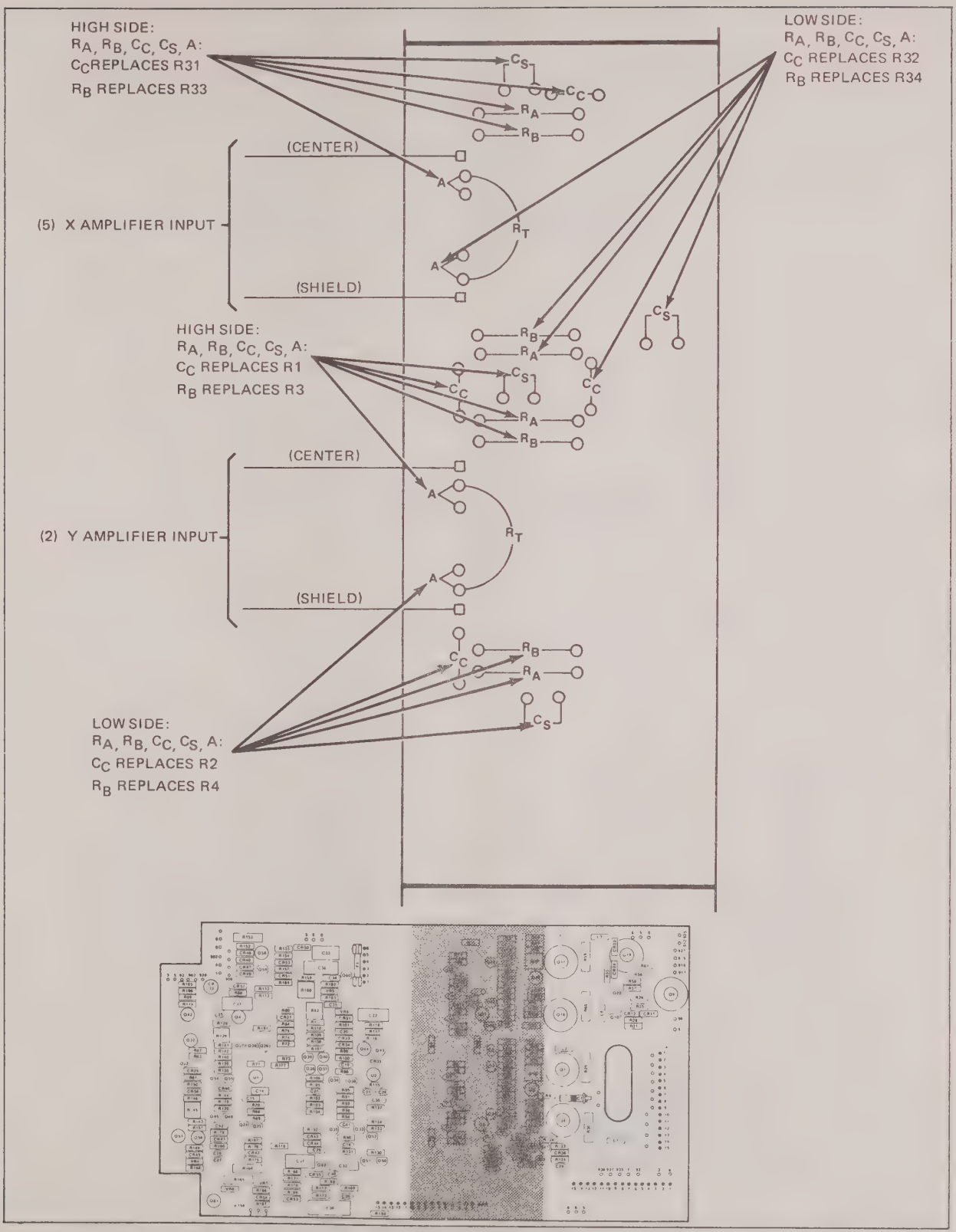


Figure 3-4. X- and Y-Amplifier Input Modification Schematic and Component Locations (Sheet 2 of 2)

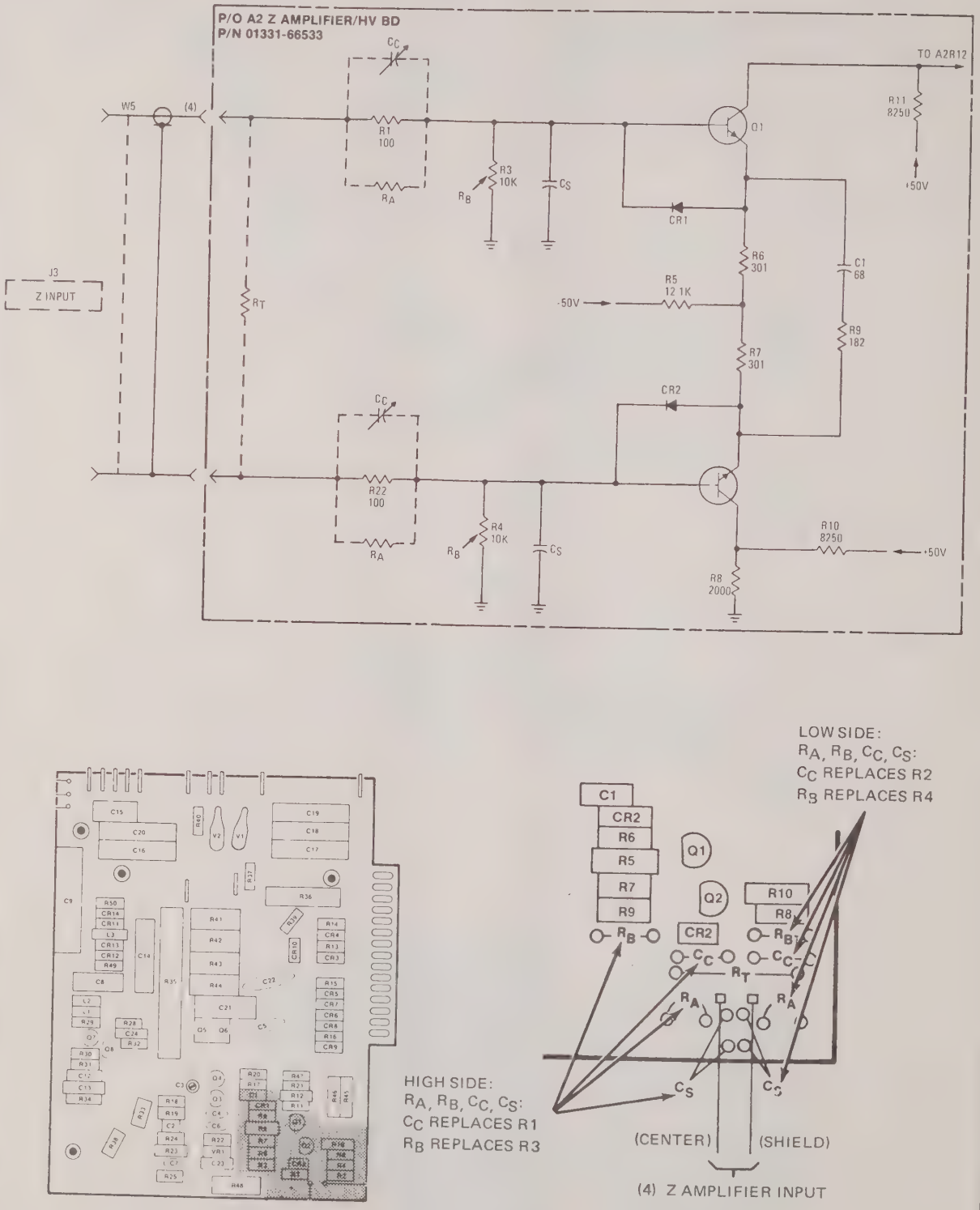


Figure 3-5. Z-Amplifier Input Modification Schematic and Component Locations

Table 3-1. X- and Y-Amplifier Input Attenuator Component Values

Vfsd (Full-Scale Deflection Voltage)	RA	RB	CC	CS
1 (As Shipped)	Not Used (NU)	NU	NU	NU
2	51.1K	51.1K	5.5-18 pF	NU
5	82.5K	20K	5.5-18 pF	33 pF
10	90.9K	10K	NU	NU

Input impedance remains at approximately 100K each combination of values.

Table 3-2. Z-Amplifier Input Attenuator Component Values

Vmax	RA	RB	CC	CS
1 (as shipped)	NU	NU	NU	NU
2	5110	5110	9-35 pF	20
10	9090	1000	NU	NU

Input impedance remains at approximately 10K for each combination of values.

Table 3-3. X—, Y—, and Z-Amplifier Input Attenuator Component Parts List

Description	HP Part No.
R: fixed, metal film, 100K ohms 1% 1/2W	0757-0367
R: fixed, metal film, 90.9K ohms, 1% 1/4W	0757-0775
R: fixed, metal film, 82.5K ohms, 1% 1/2W	0757-0048
R: fixed, metal film, 51.1K ohms, 1% 1/2W	0757-0853
R: fixed, metal film, 20K ohms, 1% 1/2W	0757-0190
R: fixed, metal film, 10K ohms, 1% 1/2W	0757-0839
R: fixed, metal film, 10K ohms, 1% 1/8W	0757-0442
R: fixed, metal film, 9090 ohms, 1% 1/8W	0757-0288
R: fixed, metal film, 5110 ohms, 1% 1/8W	0757-0438
R: fixed, metal film, 1000 ohms, 1% 1/8W	0757-0280
R: fixed, metal film, 100 ohms, 1% 1/8W	0757-0401
C: variable, 5.5-18 pF	0121-0061
C: variable, 9-35 pF	0121-0046
C: fixed, 33 pF	0160-2150

SECTION IV

PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. This section contains a simplified explanation of the principles of variable persistence and storage. It also contains functional descriptions of Model 1331A keyed to an overall block diagram and to block diagrams of circuit groups. A detailed explanation of circuit functions, keyed to the schematics, is provided after the block diagram discussion.

4-3. VARIABLE PERSISTENCE AND STORAGE.

4-4. The following simplified explanations are provided as a prerequisite to the study of Model 1331A circuitry. This discussion assumes that the reader understands the operation of conventional cathode-ray tubes.

4-5. THE STORAGE CRT. The storage CRT contains all the conventional CRT elements: an electron gun (called the write gun), electrostatic deflection plates, a post accelerator, and an aluminized phosphor viewing screen. The storage CRT also contains several additional elements: a second electron gun (called the flood gun), a collimator, a collector mesh, and a storage mesh. Figure 4-1 illustrates the relative positions of these elements in the storage CRT.

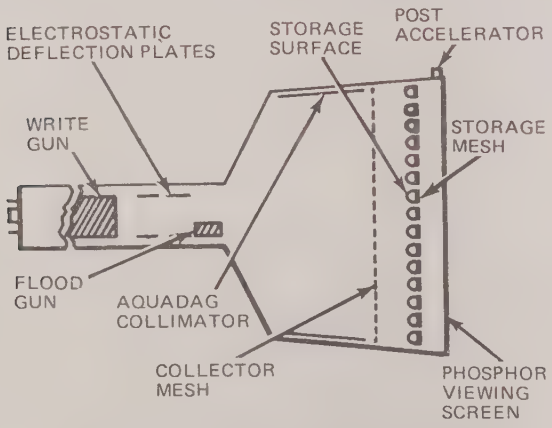


Figure 4-1. Storage CRT Elements

4-6. The purpose of the flood gun is to emit a cloud (not a sharply focused beam) of electrons that are accelerated toward the front of the CRT. The collimator causes the flood gun electrons to travel forward on lines perpendicular to the front of the CRT. The collimator also shapes the cloud of electrons to evenly cover the target area (collector mesh, storage mesh, and phosphor screen). The collector mesh is an electronically transparent, metallic mesh. The storage mesh is also electronically transparent and is covered with a special coating. The functions of the two meshes become apparent as this discussion progresses.

4-7. As electrons approach the target area, individual electrons become involved in actions that make storage and variable persistence possible. These actions are a result of the secondary emission phenomenon from the coating on the storage mesh.

4-8. The special coating is a dielectric material and is deposited on the electron-guns side of the storage mesh. The outside surface of the dielectric coating is called the storage surface. Because of capacitive coupling between the metallic storage mesh and the storage surface, it is possible to charge the storage surface negatively with respect to the storage mesh.

4-9. At any given point in time, the actual potential of any point on the storage surface depends on two things: (1) the potential on the storage mesh, and (2) the number of electrons at the particular point. As electrons arrive at the storage surface they cause a change in the potential of the surface because the striking electrons dislodge other electrons from the surface. This phenomenon is called secondary emission, and the ratio of the number of electrons leaving the surface to the number arriving is called the secondary emission ratio. The collector mesh collects the dislodged electrons.

4-10. Figure 4-2 illustrates the secondary emission ratio as a function of storage surface potential. The point on the curve where the secondary emission ratio equals 1 is called a crossover point. The exact value of the secondary emission ratio is of little importance to this discussion, but the difference in the behavior of the storage surface when above and below the crossover point is the vital principle of operation for a storage CRT. When any point on the storage surface is above the crossover point, that point tends to charge positively toward the storage mesh voltage because the secondary emission ratio is greater than 1 and more electrons are lost through secondary emission than are attracted and held. When any point on the storage surface is below the crossover point, but above the flood gun cathode voltage, that point tends to charge negatively toward the cathode potential because the secondary emission ratio is less

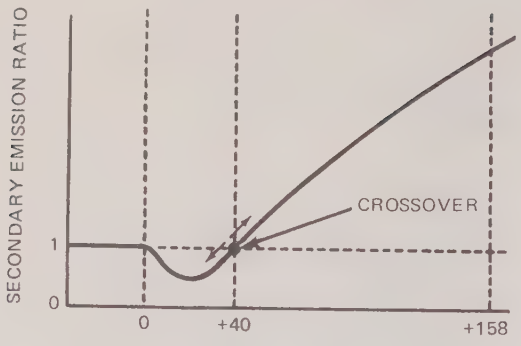


Figure 4-2. Secondary Emission Ratio

than 1 and more electrons are captured than are lost. If the point is charged below (more negative than) the cathode, it tends to remain static because all flood electrons are captured by the collector mesh; none arrive at the storage surface and none leave, so the secondary emission ratio is 1.

4-11. Assume a condition where the storage mesh is at some quiescent voltage below the crossover point, say about +3.5 volts. Also assume that the storage surface is uniformly negative with respect to the storage mesh, say about —10 volts. Suddenly the write gun turns on and the sharply focused write beam sweeps across the storage surface. The electrons in the write beam are at a much higher energy level than the flood electrons so that the beam penetrates to and strikes the storage surface so hard the point is carried above crossover and many electrons are knocked off (secondary emission). The potential at the impact point rises due to the loss of electrons. Because these points have become more positive, flood electrons pass through and are accelerated to the phosphor viewing screen by the post-accelerator potential. If the write beam is removed, flood electrons will continue to pass through the area previously traversed by the write beam and continue to excite the phosphor on the viewing screen. In this manner, writing and storage are accomplished on the storage surface.

4-12. Once written and stored, a pattern on the storage mesh tends to remain there until removed by some means. Figure 4-3 illustrates the potentials on the storage mesh and storage surface during an erase cycle. Solid lines represent voltages applied to the storage mesh. Dashed lines represent storage surface voltages. Shaded areas show voltage variations of written areas on the storage surface. Initially, the storage mesh is held at +3.5 volts, the unwritten areas of the storage surface are at —10 volts, and the written areas vary between 0 volts and —10 volts. Because the written areas are at or below 0 volts (flood gun cathode voltage) they tend to remain static. At the beginning of the erase cycle, a very fast step voltage raises the storage mesh to +158 volts. About 154 volts is capacitively coupled to the storage surface and it rises to about +144 volts. This voltage is well above the crossover point, so all areas on the storage surface continue to charge rapidly toward the storage mesh voltage (+158V). The voltage cannot rise above +158 volts because the storage mesh is coupled to the collector mesh (also at +158V) by the electron cloud. Now, both the storage mesh and all

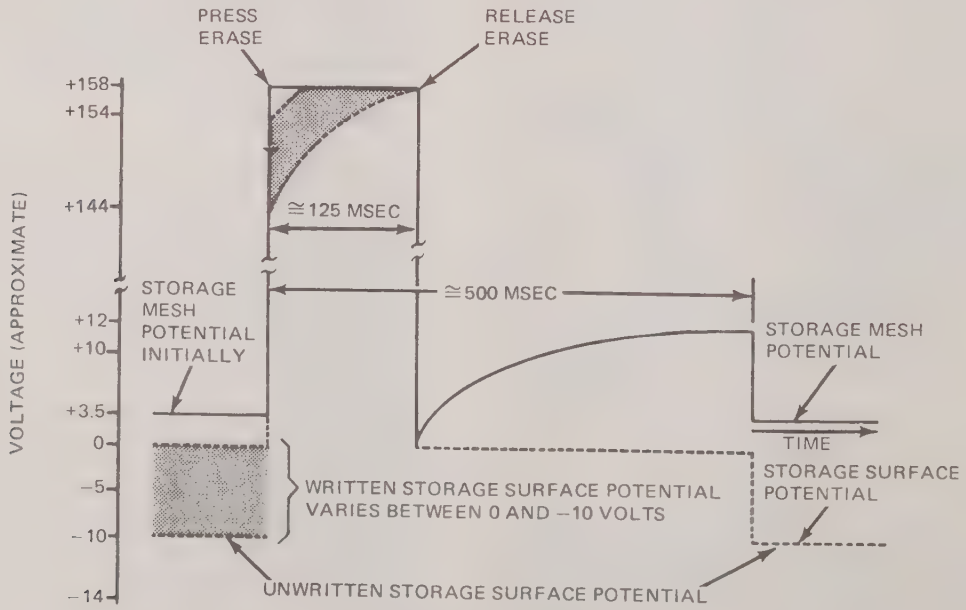
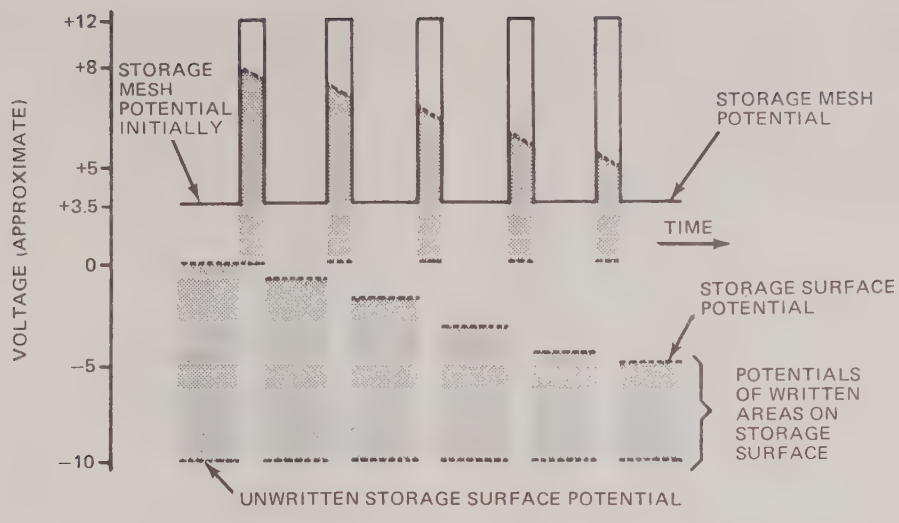


Figure 4-3. Erase Cycle



NOTE: PERSISTENCE IS THE AMOUNT OF TIME REQUIRED TO REDUCE THE STORAGE SURFACE POTENTIAL TO −10 VOLTS AND CAN BE VARIED BY CHANGING THE PULSE WIDTH OR FREQUENCY OF THE PULSE DUTY CYCLE.

Figure 4-4. Variable Persistence Pulsing

points on the storage surface are equally at +158 volts. Next, another fast step voltage carries the storage mesh to 0 volt. About +158 volts is capacitively coupled to the storage surface and it follows the storage mesh to 0 volt. A slowly rising ramp carries the storage mesh to about +12 volts. The storage surface is below crossover so the negative charge rate caused by secondary emission matches the positive charge rate caused by capacitive coupling, and the charge on the storage surface stabilizes at 0 volt. The last part of the erase cycle is a fast step voltage that carries the storage mesh to +3.5 volts. Again, a negative 10-volt step is capacitively coupled to the storage surface causing its potential to drop to −10 volts. This causes all written information to be removed, and the storage surface is ready to store new information.

4-13. VARIABLE PERSISTENCE. It is possible to disable the storage elements in the CRT so that the write beam directly excites the phosphor viewing surface. In such a mode, persistence is fixed and depends only on the type of phosphor used. Model 1331A uses a method that permits persistence to be varied. Variable persistence operation requires some method of removing stored information; otherwise, the information, once written, remains on the storage surface until an erase cycle is initiated or until natural storage time (in excess of 15 minutes) elapses.

4-14. Figure 4-4 shows how variable persistence is accomplished. Solid lines represent storage mesh potentials and dashed lines represent storage surface potentials. Shaded areas represent written areas on the storage surface. Initially, the storage mesh is held at +3.5 volts, the unwritten areas of the storage surface are at −10 volts, and the written areas vary between 0 and −10 volts. A fast step voltage applied to the storage mesh carries the storage mesh potential to +12 volts. About eight volts is coupled to the storage surface causing its highest potential point to rise to +8 volts. This is well below crossover (see figure 4-2), so the surfaces charge negatively toward the flood gun cathode voltage (0 volt). When the voltage reaches about +7 volts, a fast step voltage carries the storage mesh back to +3.5 volts. This voltage change is coupled to the storage surface and its potential falls to about −1 volt. Note that potentials of the written areas have been reduced. Each pulse applied to the storage mesh results in a drop in potential on the storage surface until, finally, the potential over the entire surface has been reduced to −10 volts. Persistence (the amount of time required to reduce the potential to −10 volts) is varied by changing the pulse duty cycle. This can be done by changing pulse width or by varying pulse frequency.

4-15. A side effect of pulse train erasure is a light background glow over the entire CRT viewing area. During pulse time, a few flood electrons pass through all areas of the storage mesh, evenly exiting the viewing surface.

4-16. STORAGE. In store mode, erase pulses are not applied to the storage mesh and, theoretically, anything written on the storage surface remains there indefinitely until an erase cycle is initiated. In a practical CRT, however, store time is limited by an effect called fade positive. This occurs on the storage surface and is caused by ionization of residual gas

molecules by flood electrons. The storage surface gradually charges more positive allowing flood electrons to penetrate to the phosphor viewing area where they increase background illumination until the display is obscured. Fade positive is reduced (and store time increased) by keeping the flood gun turned off in store mode except for brief periods to refresh the display. An interval of store time greater than the specified 15 minutes (see table 1-1) may be achieved at the expense stored trace of brightness by decreasing the percentage of time that the flood gun is turned on. This may be accomplished by resetting the store time potentiometer, A4R30.

4-17. STORAGE PRECAUTIONS. Write beam electrons striking the storage surface cause a rapid increase in potential. Energy from this sudden change is converted to heat and, when it exceeds the heat dissipation rating of the storage surface, burns the dielectric. The burning is visible as trace blooming. The write beam intensity level should always be set below the point where blooming occurs.

4-18. BLOCK DIAGRAM DISCUSSION.

4-19. This discussion explains the relationships of the circuit groups to each other. It is based on the overall instrument (see figure 8-1) and write/store/erase pulse circuitry (see figures 8-2, 8-3, 8-4) block diagrams located in Section VIII.

4-20. LOW-VOLTAGE POWER SUPPLY. The low-voltage power supply provides regulated dc operating power for the other blocks in the instrument (including the high-voltage power supply). Outputs at four dc voltages are supplied: —50V, +50V, +12.6V, and +158V. The —50V supply is adjustable and all the other supplies are referenced to it. The 12.6V supply is also adjustable.

4-21. HIGH-VOLTAGE POWER SUPPLY. The high-voltage power supply provides voltage to operate the CRT: —2915 volts for the write gun cathode, —2955 volts for the intensity grid, and +7.5 kilovolts for the post accelerator. The write gun intensity limit adjustment, the high-voltage adjustment, and the focus control are part of the high-voltage supply. Note that write gun intensity grid supply is in series with the output of the gate amplifier.

4-22. GATE AMPLIFIER. Intensity is controlled by three inputs to the gate amplifier: the dc output of the INTENSITY control, the dynamic output from the z-amplifier, and the blanking signal from the pulse circuits. The three inputs are summed in the input circuit and drive the gate amplifier. The amplitude of the blanking signal is large enough to override the other inputs. The gate amplifier provides the dynamic range to drive the CRT between maximum brightness and complete cutoff.

4-23. Z-AMPLIFIER. The signal from the Z INPUT is amplified to provide the voltage and current gain required to drive the gate amplifier. This permits external intensity control (z-axis modulation).

4-24. X- AND Y-AMPLIFIERS. The x- and y-amplifiers are nearly identical and amplify input signals to the necessary levels to drive the CRT horizontal and vertical deflection plates, respectively. POSITION and BEAM FIND controls are included in these blocks as well as the gain and phase shift adjustments.

4-25. PUSHBUTTON ASSEMBLY. The pushbuttons initiate the mode function (write and store) and erase cycle of Model 1331A by applying an open (logic HI) or a ground (logic LO) to the two input lines to the program board. The write and erase pushbuttons are electrically linked together; note that the logic LO to the erase line can only be applied through the closed contacts of the write switch. The write and store switches are mechanically linked together; closing the store switch causes the write switch to open.

4-26. PROGRAM CIRCUITS. The program circuits condition the logic levels on the two input lines. The conditioning process includes shaping, conversion to required output voltage levels, polarity, and activation of a calibrated current source. A momentary logic LO on the erase input causes a 125 ms pulse at the erase output. The logic states for the two mode conditions are as shown on the block diagram.

4-27. PULSE CIRCUITS. The pulse circuits receive logic signals on three input lines and generate the waveforms and voltages required to operate the storage elements of the CRT. Because of the complicated logic configuration of the pulse circuits, and because the logic configuration is different for each mode and function, a mode-to-mode explanation is not provided relative to the overall block diagram. Three separate block diagrams have been provided for this purpose, i.e., to explain each logic configuration of the pulse circuits in the write mode, store mode, and erase cycle. These block diagrams are located in Section VIII and contain logic symbols for significant components. The input(s) and output(s) of each block are marked with a logic state, a waveform, or a dc voltage. Notes along the various logic and signal paths explain functions that may not be obvious.

4-28. Write Mode. In this configuration, the pulse circuits must apply: (1) the calibrated collimator voltage, (2) an unblanking voltage to the gate amplifier, (3) a dc flood gun accelerator voltage, and (4) variable persistence duty-cycle erase pulses to the storage mesh. The duty cycle of the pulse train is changed by varying the pulse frequency. Pulse frequency is changed by varying the pulse generator input current. Pulse generator input current is supplied from the PERSISTENCE potentiometer.

4-29. Store Mode. In this configuration, the pulse circuits must apply: (1) the calibrated collimator voltage (2) a blanking voltage to the gate amplifier, (3) a deflecting voltage to one side of the y amplifier, (4) calibrated duty cycle pulses to the flood gun accelerator, and (5) a dc voltage to the storage mesh. The pulse generator input current is calibrated by supplying the current from the Store Time Adj potentiometer.

4-30. Erase Cycle. In this configuration, the pulse circuits must apply: (1) a modulated 500-millisecond overcollimating pulse to the collimator, (2) a 500-millisecond blanking pulse to the gate amplifier, (3) a 500-millisecond deflecting pulse to one side of the y-amplifier, (4) a dc flood gun accelerator voltage, and (5) a 500-millisecond complex waveform to the storage mesh. Before and after the erase cycle, the pulse circuits are in the write mode. The erase cycle is initiated by a 125-millisecond pulse on the erase input; the duration of this pulse is called prime time. During the erase cycle, the output of the pulse generator is inhibited and the waveform to the storage mesh is a combination of the outputs of the prime switch and the Miller integrator. The timing is controlled by the output of the erase cycle timing switch.

4-31. SCHEMATIC DISCUSSION.

4-32. The following paragraphs are intended as a guide to understanding the functioning of the instrument and are not a discussion of basic electronics. For instance, the text may state that a circuit is a Miller integrator and assume that the reader knows how a Miller integrator works. Unusual circuits are explained in greater detail. The discussions are keyed to the schematics (see figures 8-6, 8-7, 8-8, 8-9, 8-10) in Section VIII. A reference is made to the appropriate schematic at the pertinent point in each discussion.

4-33. X- AND Y-AMPLIFIERS. (See schematic 1). Because the x- and y-amplifiers are nearly identical, only the y-amplifier is discussed.

4-34. Input Stage. The input stage consists of two Darlington pairs (A1Q1A/A1Q2 and A1Q1B/A1Q3) connected as a differential emitter-follower pair. This configuration provides high input impedance and current drive for following stages.

4-35. Gain Stage. Common-emitter differential amplifier A1Q4/A1Q5 provides variable gain. Vertical gain is controlled by Y Gain potentiometer A1R18.

4-36. Output Stage. The output stage consists of two cascoded pairs (A1Q6A/A1Q7 and A1Q6B/A1Q8) connected as a differential pair with a common current source (A1Q9 and A1W10). Vertical position control is accomplished in this stage by changing the division of current through the two halves of the differential amplifier when the VERT POSITION control, R1, is adjusted. Compensation for phase shift (unequal output capacitances at outputs of x- and y-amplifiers) is accomplished by Phase Adj A1C7. The current source is interrupted when the BEAM FIND switch, S1, is activated. This reduces the dynamic range of the stage to the point where the beam cannot be deflected off the CRT screen.

4-37. CONTROL CIRCUITS. (See schematic 2). The control circuits consist of the pushbutton assembly, A3, and the program board, A4.

4-38. Pushbutton Assembly. Pushing the write pushbutton applies a ground to the A4R11/A4R12/A4R13 junction to initiate the write mode. Pushing the store pushbutton mechanically causes the write pushbutton to open. This removes the ground from the junction and initiates the store mode. The erase cycle can be initiated only when the write pushbutton is closed. Pushing the erase pushbutton then applies a momentary ground to the A4R1/A4R2 junction to initiate the erase cycle.

4-39. Program Board. All transistors, except monostable multivibrator A4Q2/A4Q3, function as simple on/off switches. In the write mode, a logic LO at the base of A4Q4 causes a logic LO at the mode output line. It also causes (through A4R24) a logic LO at the collector of A4Q7. This reverse biases A4CR3, disconnecting the Store Time Adj potentiometer, A4R26, from the store time output line.

4-40. In the store mode, a logic HI at the base of A4Q4 causes a logic HI on the mode output line. It also causes a logic HI at the collector of A4Q7. This forward biases A4CR3 and connects Store Time Adj potentiometer, A4R26, to the store time output line.

4-41. To initiate the erase cycle, a momentary logic LO at the base of A4Q1 triggers monostable multivibrator A4Q2/A4Q3 to cause a positive-going, 125-millisecond pulse on the erase output line

4-42. PULSE CIRCUITS. (See schematic 3). The circuits are discussed as functional groups. A particular circuit may be included in more than one group.

4-43. Pulse Generator Group. The pulse generator is an integrated circuit (A1U1) externally configured to function as an astable multivibrator. Enable switch A1Q25, when turned on, grounds pin 4 and disables the pulse generator. The input logic connects current source A1Q24 to one of two different current controls by configuring two transistor switches: persistence switch A1Q22 and store time gate A4Q7 (see schematic 2). Only one switch is turned on at a time. When a switch is turned on (output saturated),

it grounds its associated diode and reverse biases it. When a switch is turned off, its collector voltage rises and forward biases the associated diode. The two sources connected by diodes A1CR25 and A4CR3 are: the PERSISTENCE potentiometer, R3, and the Store Time Adj potentiometer, A4R26.

4-44. Pulse Control Group. This group consists of three transistor switches and a logic inverter. Store disable switch A1Q34 and flood gun switch A1Q35 require the complement of the MODE logic function; inverter A1Q33 performs this inversion. Store disable switch A1Q34 turns pulse switch A1Q28 on and off. Pulse switch A1Q28, in turn, controls the output of pulse shaper A1Q27. Flood gun switch A1Q35 controls the output of flood gun pulser A1Q37/A1Q38/A1Q39.

4-45. Main board A1 is also used on other Hewlett-Packard instruments. Delay circuit A1Q36 and erase disable switch A1Q26 have no significant function in Model 1331A.

4-46. Pulse Output Group. The output of the pulse generator can be applied to the storage mesh and collector mesh or through another path to the flood gun accelerator.

4-47. Pulse inversion, level shifting, and amplitude adjustment are accomplished by pulse shaper A1Q27. The output of this stage can be inhibited by pulse switch A1Q28. When A1Q28 turns on, it grounds the output of A1Q27 placing the output in the logic LO state. Write Depth Adj, A1R82, sets the level of positive excursion of the output pulse.

4-48. Storage mesh driver A1Q32 is driven from one of two different sources: the output of the pulse shaper, A1Q27, and the output of the Miller intergrator, A1Q43/A1Q44 (during erase cycle). A pulse or dc output from one of these sources drives the storage mesh, except during prime time (initiating part of the erase cycle), when a +158-volts pulse overrides the output of the storage mesh driver.

4-49. Flood gun pulser A1Q37/A1Q38/A1Q39 shapes and amplifies the pulses from the pulse generator. When turned on, flood gun switch A1Q35 inhibits the output of the flood gun pulser by grounding the collector of A1Q39. Flood gun driver A1Q40 drives the flood gun accelerator with either the pulse output of the flood gun pulser or with a dc voltage.

4-50. Erase Group. The erase cycle timer A1U2 is an integrated circuit externally configured to function as a one-shot multivibrator. A 125-millisecond input pulse momentarily turns erase switch A1Q52 on to trigger the erase cycle timer. Output pulse duration is 500 milliseconds.

4-51. Prime switch A1Q41/A1Q42 is turned on for the duration of the 125-millisecond input pulse. A1Q42 applies +158 volts directly to the CRT storage mesh.

4-52. The 125-millisecond input pulse triggers Miller integrator A1Q43/A1Q44. The output of A1Q44 drops to 0 volt during prime time. This forward biases A1CR31. At the same time, the output of the erase cycle timer inhibits the pulse generator output. Following prime time, the Miller integrator ramp appears at the output of storage mesh driver A1Q32 where it continues to rise until the rising ramp reaches the level set by the pulse shaper and reverse biases A1CR31. When the timing pulse from the erase cycle timer ends, the pulse generator is again enabled.

4-53. Under some conditions, when Model 1331A is turned off, a prime pulse is initiated from prime switch A1Q41/A1Q42. This pulse will charge the storage mesh above the crossover point. This charge is not dissipated during the time the instrument is turned off. The CRT storage surface will be damaged (if it is not erased) when the instrument is turned on. CRT protect circuit A1Q50/A1Q51 prevents initiation of a prime pulse when the instrument is turned off and assures that the storage mesh is held below the crossover point.

4-54. Write Gun Control Group. The write gun must be turned off in the store mode to prevent the stored pattern from being overwritten. During the erase cycle, it must be turned off to prevent rewriting of the pattern being erased. Normally, blanking switch A1Q49 is turned on to apply a ground (unblanking level) to the input of the gate amplifier (see schematic 4). When the blanking switch is turned off, its collector voltage rises to the positive blanking level.

4-55. Some slight amount of emission from the write gun is possible even when blanked. If a large deflecting voltage is applied to one CRT deflection plate, the transient emissions are deflected away from the target area. In the store mode or during the erase cycle, deflection switch A1Q46/A1Q47/A1Q48 turns on and applies —50 volts through A1Q48 to one side of the y-amplifier (see schematic 1) to deflect the write gun beam off screen.

4-56. The signals to the deflection switch and the blanking switch require inversion; inverter A1Q45 performs this function. A1Q45 has two inputs: one from the mode line to cause blanking in store mode and one from the output of the erase cycle timer to cause blanking during the erase cycle.

4-57. Collimator Control Group. Normally, collimator switch A1Q54/A1Q55 is turned on and A1Q55 applies a ground to the components connected to its collector. The output of the collimator driver is the calibrated (by Collimator Adj A1R145) collimator voltage. During erase cycle, the pulse output from the erase cycle timer causes collimator switch

A1Q54/A1Q55 to open, permitting A1CR40 to turn on. This causes the output of the collimator driver to be a positive pulse whose top is modulated by a 60-Hz alternating voltage. This pulse enhances the erasing action as explained in the following paragraph.

4-58. When properly collimated, the flood gun beam is perpendicular to the collector mesh and the storage mesh. In this condition, areas in the shadow of the collector mesh would not be completely erased. Applying an overcollimating voltage causes the beam to approach at an angle so that the electrons are able to charge the shadow area. Modulating the pulse causes a sweeping action to further enhance uniformity of erasure.

4-59. HIGH VOLTAGE POWER SUPPLY. (See schematic 4). When the instrument is first turned on, Q5 starts to conduct through the primary winding of A5T1. Positive feedback to the base of Q5 occurs through the tertiary winding of A5T1, and the circuit oscillates at a rate determined by the distributed inductance and capacitance of the circuit. The conduction angle of Q5 (operating class C), and consequently the voltage of the output, is controlled by the voltage at the collector of A2Q7.

4-60. A sample of the +50-volt power supply (selected by High Voltage Adj A2R33) establishes a reference at the base of A2Q8. A sample of the CRT cathode voltage is also fed to the base of A2Q8 and compared with the reference voltage. Any difference (error) is amplified by A2Q8 and A2Q7. The amplified difference drives the base of Q5 through the tertiary winding of A5T1 in such a direction as to correct the error.

4-61. The oscillations are stepped up by A5T1, rectified by A5CR1 and A5CR2, filtered by the R and C components on A5 and A2, and applied as operating potentials to the CRT. The oscillations from a tap on A5T1 are rectified, tripled, and filtered by tripler assembly A6 and applied to the CRT post accelerator.

4-62. The CRT control grid supply is returned to the output of the gate amplifier, so that the CRT control grid voltage, at a given instant, is a function of the gate amplifier.

4-63. Z- AND GATE AMPLIFIERS. (See schematic 4). There are three inputs to the gate amplifier: (1) the dc output from the INTENSITY control, (2) the dynamic output of the z-amplifier, and (3) the pulse output of blanking switch A1Q49 (see schematic 3). The inputs are summed and the composite signal drives the gate amplifier to control the brightness (or blanking) of the CRT. A2Q5 and A2Q6 are a complementary output amplifier. A2Q3 and A2Q4 are emitter-follower drivers for A2Q5 and A2Q6 respectively.

4-64. Z-amplifier A2Q1/A2Q2 is a differential amplifier with differential input and single-ended output. It provides the amplification and impedance conversion required to drive the gate amplifier.

4-65. LOW-VOLTAGE POWER SUPPLIES. (See schematic 5). The low-voltage power supplies convert line voltage to four regulated dc voltages: +50 volts, —50 volts, +12.6 volts, and +158 volts. The low-voltage power supplies consist of a primary power circuit, a secondary power circuit, and a regulator circuit for each of the dc outputs.

4-66. Primary Power. Model 1331A can be operated from 100V, 120V, 220V, or 240 Vac. POWER ON switch S2 applies power through LINE VOLTAGE SELECT switch S3 to the primary windings of transformer T1. Line fuse F1 prevents excessive current from damaging the instrument.

4-67. Secondary Power. The ac voltage across each secondary winding is full-wave rectified by a bridge rectifier. The output of each rectifier is filtered and applied to a regulator. Transformer T1 also supplies 6.3 Vac for the write gun cathode filament.

4-68. —50-Volt Regulator. A sample of the output is selected at the —50V Adj potentiometer, A8R22, applied at the base of A8Q5, and compared with a reference voltage (developed by A8VR4) on the base of A8Q4. Any difference is amplified and applied to the base of A8Q3. Series regulator Q4 is driven by A8Q3 in such a direction as to correct the error.

4-69. +50-Volt Regulator. The +50-volt power supply is referenced to a sample of the —50-volt power supply at the base of A8Q2. A sample of the output of the +50-volt supply is compared to the reference voltage. Any difference is amplified by A8Q2 and applied to the base of A8Q1. Series regulator Q3 is driven by A8Q1 in such a direction as to correct the error.

4-70. +158-Volt Regulator. The +158-volt power supply is referenced to the —50-volt power supply at the base of A1Q62. Any error in the +158-volt power supply is compared to the reference voltage. The difference is amplified by A1Q62 and applied to the base of A1Q61. Series regulator Q2 is driven by A1Q61 in such a direction as to correct the error.

4-71. +12.6-Volt Regulator. A sample of the output of the 12.6-volt power supply is selected and compared to a sample of the —50-volt power supply at the base of A1Q59. Any error (difference) is amplified by A1Q59 and applied to the base of A1Q58. Series regulator Q1 is driven by A1Q58 in such a direction as to correct the error.

4-72. Overvoltage Protect Circuit. If the 12.6-volt regulator fails to regulate and the output voltage rises excessively, avalanche diode A1VR5 conducts and triggers controlled rectifier A1Q60. The output line is grounded by A1Q60 causing fuse A1F1 to blow, removing the overvoltage.

Table 5-1. Recommended Test Equipment

Instrument		Required Characteristics	Required For
Type	Model		
Monitor Oscilloscope	HP 1700B	Bandwidth: 20 MHz Sweep Speed: to 50 ns/div Sweep accuracy: ±3%	Performance Checks Adjustment
Voltmeter	HP 34701A meter with 34740A Digital Display	Accuracy: ±0.5% Resolution: Full 4-Digit Input Impedance: Constant on all ranges ±1%	Adjustments
Test Oscillator	HP 651B	Output: flat ±0.5 dB Range: 10 kHz - 1 MHz	Performance Checks Adjustments
Voltmeter Calibrator	HP 738BR	Output: 1V p-p sine wave Accuracy: ±0.5% into 10K impedance	Adjustments
Square Wave Generator	HP 211B	Rise time: <10 ns Total Perturbations: <5%	Performance Checks
Pulse Generator	HP 8002A	Pulse width: 3 usec Polarity: switchable positive or negative	Performance Checks Adjustments
Function Generator (2)	HP 3311A	Output: triangle wave Frequency: 70 Hz - 4 kHz Amplitude: 1V p-p	Performance Checks Adjustments
1000:1 Probe	Pomona 2900A	Divide Ratio: 1000:1 Input R: ≥100 MΩ	Adjustments
10:1 Probe	HP 10004B	Input R: 10 MΩ Input C: ≤10 pF	Performance Checks Adjustments
1:1 Probe	HP 10007B	Direct connection	Performance Checks Adjustments
BNC TEE	HP 1250-0787	3 female BNC connectors	Performance Checks Adjustments
Dual Banana to BNC Adaptor (2)	HP 10519A	Male dual banana connector and female BNC connector	Performance Checks Adjustments
BNC Shorting Plug	HP 1250-0774	Male BNC connector with shorting strap between center and shell	Performance Checks
Miscellaneous Coaxial Cables		50Ω coaxial cables with male BNC connectors on each end	Performance Checks Adjustments

SECTION V

PERFORMANCE CHECKS AND ADJUSTMENTS

5-1. INTRODUCTION.

5-2. This section contains procedures for checking instrument performance in accordance with specifications listed in table 1-1 of this manual. Performance check record forms are provided for recording measurements taken during the first running of the procedures. The procedures for making all internal adjustments are covered in paragraphs 5-25 through 5-43, and adjustment locations are shown in figures 5-10 through 5-13. Perform the preoperational procedure in Section III prior to initiating performance checks or adjustments.

5-3. Failure to obtain any required result during performance of either the checkout or adjustment procedure, the cause should be found and corrected before proceeding further. Refer to the adjustment procedures in this section and the instructions on troubleshooting in Section VIII.

5-4. The procedures require either the recommended test equipment listed in table 5-1, or equivalent test equipment. Required characteristics for equivalent test equipment are also listed in table 5-1. If the user's application does not require that the Model 1331A meet all specifications, some procedures may be omitted. Unless recommended test equipment is on hand, the procedures and test setups may require changes to adapt them to available equipment. Refer any questions regarding the procedures to the nearest Hewlett-Packard Sales/Service Office (addresses in back of manual).

5-5. PERFORMANCE CHECKS.

WARNING

Do not attempt to operate this instrument until the safety summary, located just before Section I, has been read and understood.

5-6. The following paragraphs describe procedures to determine if the instrument performance meets specifications. These procedures can be used as part of an incoming inspection, as a periodic operational test, or to check calibration after repairs and adjustments are made. Any one of the following checks can be made separately, if desired.

5-7. The first time performance checks are made, enter the results on the performance check record. Be sure to enter the instrument serial number on the record for identification. Remove the record and file it for future reference.

NOTE

Throughout the performance check procedure, best results will be obtained if BNC shorting caps are kept on all unused input connectors.

5-8. X- AND Y-DEFLECTION. A 1-volt peak-to-peak signal at the X INPUT shall cause a 10-division horizontal deflection. A 1-volt peak-to-peak signal at the Y INPUT shall cause an 8-division vertical deflection.

5-9. Perform X- and Y-deflection checks as follows:

a. Connect 1V p-p output of voltmeter calibrator to X INPUT.

b. Use HORIZ and VERT POSITION controls to center display. Horizontal deflection shall be 10 divisions ±3%.

c. Move output of voltmeter calibrator to Y INPUT. Vertical deflection shall be 8 divisions ±3%.

5-10. X- AND Y-BANDWIDTH. Bandwidth of both the horizontal and vertical amplifiers shall be down not more than 3 dB at 1 MHz.

5-11. Perform X- and Y-bandwidth checks as follows:

a. Connect output of test oscillator to X INPUT.

b. Set frequency of test oscillator to 10 kHz.

c. Set amplitude of test oscillator for 10 divisions horizontal deflection on CRT. Note reading of test oscillator output meter.

d. Change frequency of test oscillator to 1 MHz.

e. Set amplitude of test oscillator to obtain same reading on output meter as noted in step c. Horizontal deflection on CRT shall be 7.1 divisions or greater.

f. Change output of test oscillator to Y INPUT.

g. Set frequency of test oscillator to 10 kHz.

h. Set amplitude of test oscillator for 8 divisions vertical deflection on CRT, note reading of test oscillator output meter.

i. Change frequency of test oscillator to 1 MHz.

j. Set amplitude of test oscillator to obtain same reading on output meter as noted in step h. Vertical deflection on CRT shall be 5.7 divisions or greater.

5-12. PHASE SHIFT. Phase shift between the horizontal and vertical amplifiers shall be less than 1° to 500 kHz.

5-13. Perform phase shift check as follows:

a. Connect output of test oscillator to both X INPUT and Y INPUT as shown in figure 5-1.

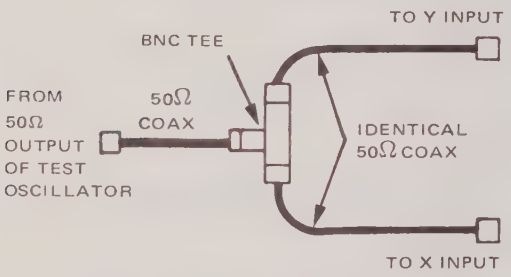


Figure 5-1. Phase Shift Test Setup

b. Set test oscillator for 500 kHz, 1V p-p output.

c. Opening on displayed ellipse shall be 0.17 divisions or less (see figure 5-2).

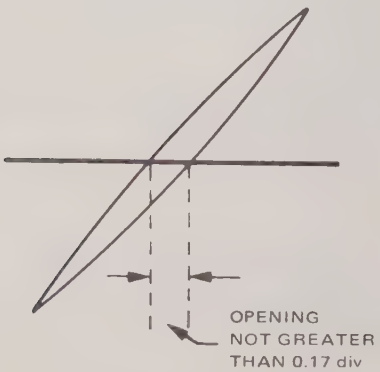


Figure 5-2. Phase Shift Display

5-14. COMMON MODE REJECTION RATIO.

NOTE

As shipped from the factory, Model 1331A does not have differential inputs. If the user does not reconfigure the X and Y input circuits for fully differential input as described in Section III, this check may be omitted.

5-15. When reconfigured for fully differential input, common mode signals at the differential inputs of the X and Y amplifiers shall be attenuated 40 dB or more for signals with amplitudes of 3V p-p or less.

5-16. Perform common mode rejection ratio check as follows:

a. Disconnect instrument from all power and signal sources.

b. Replace A1R4 and A1R34 with 100K resistors identical to A1R3 and A1R33 (see table 6-2). (Refer to schematic 1 and the A1 component locator in Section VIII).

c. Turn instrument on.

d. Install BNC shorting plug on Y INPUT. Ensure that case of shorting plug is not touching chassis.

e. Connect output of test oscillator to case of BNC shorting plug.

f. Set test oscillator for 10 kHz, 3V p-p output.

g. Observe vertical deflection on CRT. Deflection shall be equal to or less than 1.2 minor divisions.

h. Move shorting plug from Y INPUT to X INPUT.

i. Observe horizontal deflection. Deflection shall be equal to or less than 1.5 minor divisions.

j. Replace A1R4 and A1R34 with standard resistors removed to perform this test before proceeding with other checks.

5-17. SETTLING TIME. For any on-screen movement, the CRT beam shall settle to within 1 spot diameter of final value in 1 us or less.

5-18. Perform settling time check as follows:

a. Connect equipment as shown in figure 5-3. Note that Z INPUT is not yet connected.

b. Set square-wave generator for 1V p-p, 100 kHz, symmetrical output.

c. Set POSITION and INTENSITY controls for bright dots at diagonal extremes of CRT graticule.

d. Set INTENSITY ccw.

e. Connect Z INPUT.

f. Set pulse generator for external sync, 1V p-p, 1 us pulse output width.

g. Set sweep time of monitor oscilloscope to 0.1 us/div, display switch to ALT, and sync source to A ONLY TRIG.

h. Set monitor oscilloscope trigger controls to achieve stable display. If necessary, readjust symmetry control on square-wave generator to achieve synchronization between channels A and B.

i. Set pulse generator delay to 10 ns and vernier cw. Note bright dot in lower left corner of CRT.

j. Turn delay vernier on pulse generator ccw. Note distorted trace segment projecting from dot.

k. Adjust delay vernier until length of trace segment is one dot diameter.

l. Measure time difference between two transitions displayed on monitor oscilloscope. Difference shall be equal to or less than 1 us.

5-19. BLANKING AND Z-AXIS GAIN. The CRT shall be driven to maximum brightness by +1V at the Z INPUT. The CRT shall be blanked by —1V at the Z INPUT. The INTENSITY control shall cause the gate output voltage to vary from less than +2V to approximately +43 with 0V at the Z INPUT.

5-20. Perform blanking and z-axis gain checks as follows:

a. Connect a 1V p-p, 1-kHz signal to X INPUT.

b. Connect a 1V p-p, 1-kHz signal to Y INPUT.

c. Turn instrument on.

d. Connect monitor oscilloscope through 10:1 probe to output of gate amplifier, a white/black/orange wire (903) on board A2 (see figure 5-11, reference point 3).

e. Set INTENSITY ccw.

f. Connect 50-kHz, 1 us wide, positive-going pulse generator to Z INPUT.

g. Increase amplitude of pulse from pulse generator until positive excursion of pulse, on monitor oscilloscope starts to limit. Pulse output from pulse generator shall be equal to or less than 1V p-p. Pulse top on monitor oscilloscope shall be ≥+42V DC.

h. Reduce amplitude of pulse from pulse generator and set polarity switch to negative.

i. Set INTENSITY cw.

j. Increase amplitude of pulse from pulse generator until negative excursion of pulse, on monitor oscilloscope starts to clamp. Pulse output from pulse generator shall be equal to or less than 1V p-p. Negative end of pulse on monitor oscilloscope shall be approximately +2V.

k. Disconnect test equipment and connect voltmeter in place of monitor oscilloscope.

l. Vary INTENSITY over entire range. Output voltage shall vary from less than +2V to greater than +42V.

m. Disconnect all power and signal sources.

5-21. Z-AXIS BANDWIDTH AND RISE TIME. Bandwidth shall be down not more than 3 dB at 5 MHz. Rise time shall be 70 ns or less.

5-22. Perform z-axis bandwidth and rise time checks as follows:

a. Connect a 1V p-p, 1-kHz signal to X INPUT.

b. Connect a 1V p-p, 1 kHz signal to Y INPUT.

c. Turn instrument on.

d. Connect monitor oscilloscope through 10:1 probe to output of gate amplifier, white/black/orange wire (903) on board A2 (figure 5-11, reference point 3).

e. Set INTENSITY to midrange.

f. Connect 50-kHz signal from test oscillator to Z INPUT.

g. Set test oscillator output and Model 1331A INTENSITY for 25V p-p signal, as displayed on monitor oscilloscope. Ensure that there is no clipping or limiting at top or bottom of waveform.

h. Set monitor oscilloscope to 6-division vertical display.

i. Increase frequency of test oscillator to 5 MHz and set oscillator output to the same amplitude as at 50 kHz.

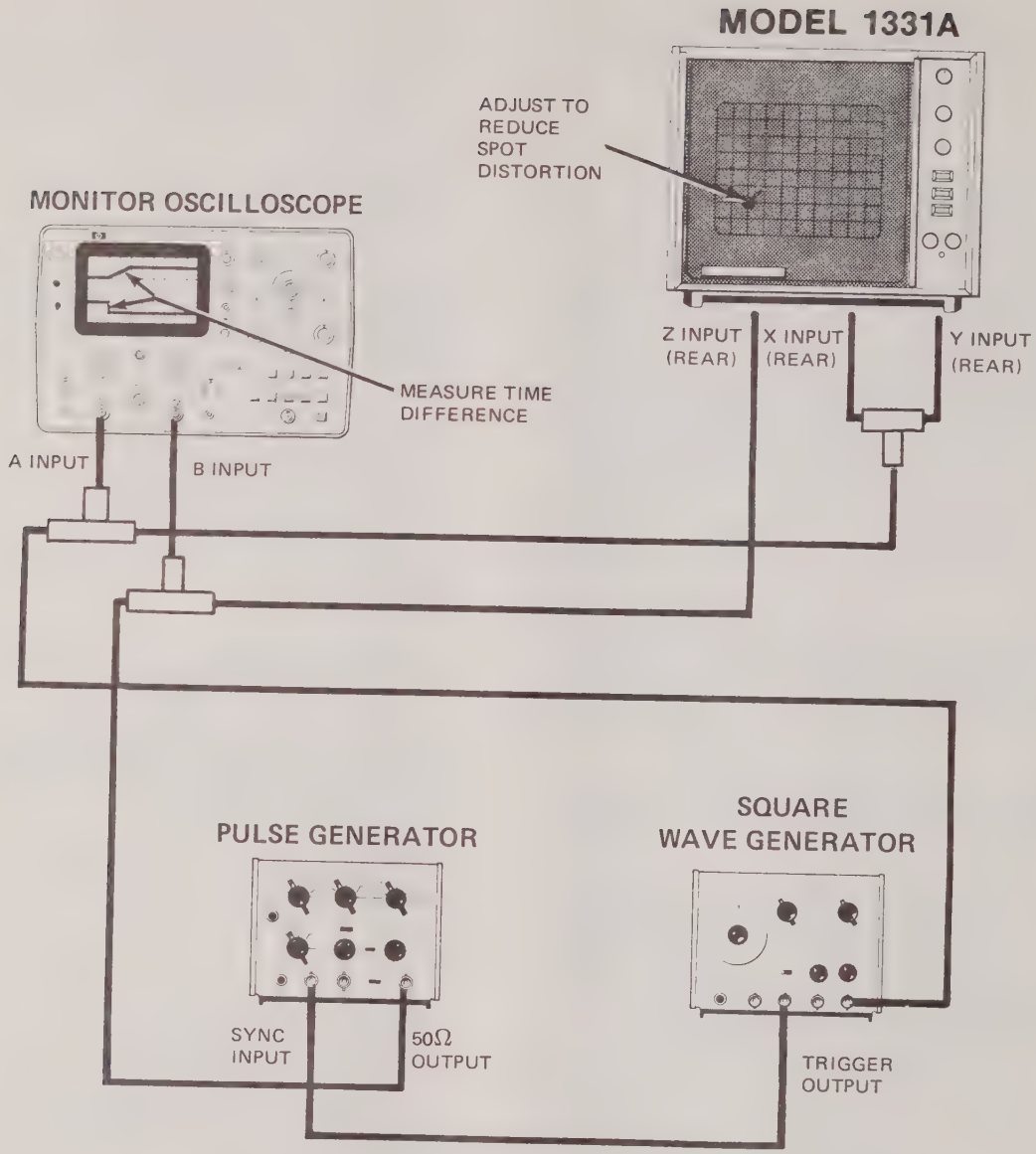


Figure 5-3. Settling Time Test Setup

j. Disconnect test oscillator.

k. Connect positive, 100-kHz pulse from pulse generator to Z INPUT.

l. Set amplitude of pulse generator and Model 1331A INTENSITY for 25V p-p pulse, as displayed on monitor oscilloscope. Ensure that there is no clipping or limiting at top or bottom of pulse.

m. Check rise time of observed pulse between 10% and 90% points. Rise time shall be 70 ns or less.

5-23. VARIABLE PERSISTENCE FUNCTIONS. Dots shall be written in 4 microseconds or less. Maximum persistence in write mode shall be 1 minute or more. In store mode, displays shall be stored 15 minutes or more. Erase cycle time shall be 500 milliseconds or less.

5-24. Perform variable persistence function check as follows:

a. Connect equipment as shown in figure 5-4. Note that pulse generator is not yet connected to Z INPUT.

b. Set function switches on both function generators to triangle function.

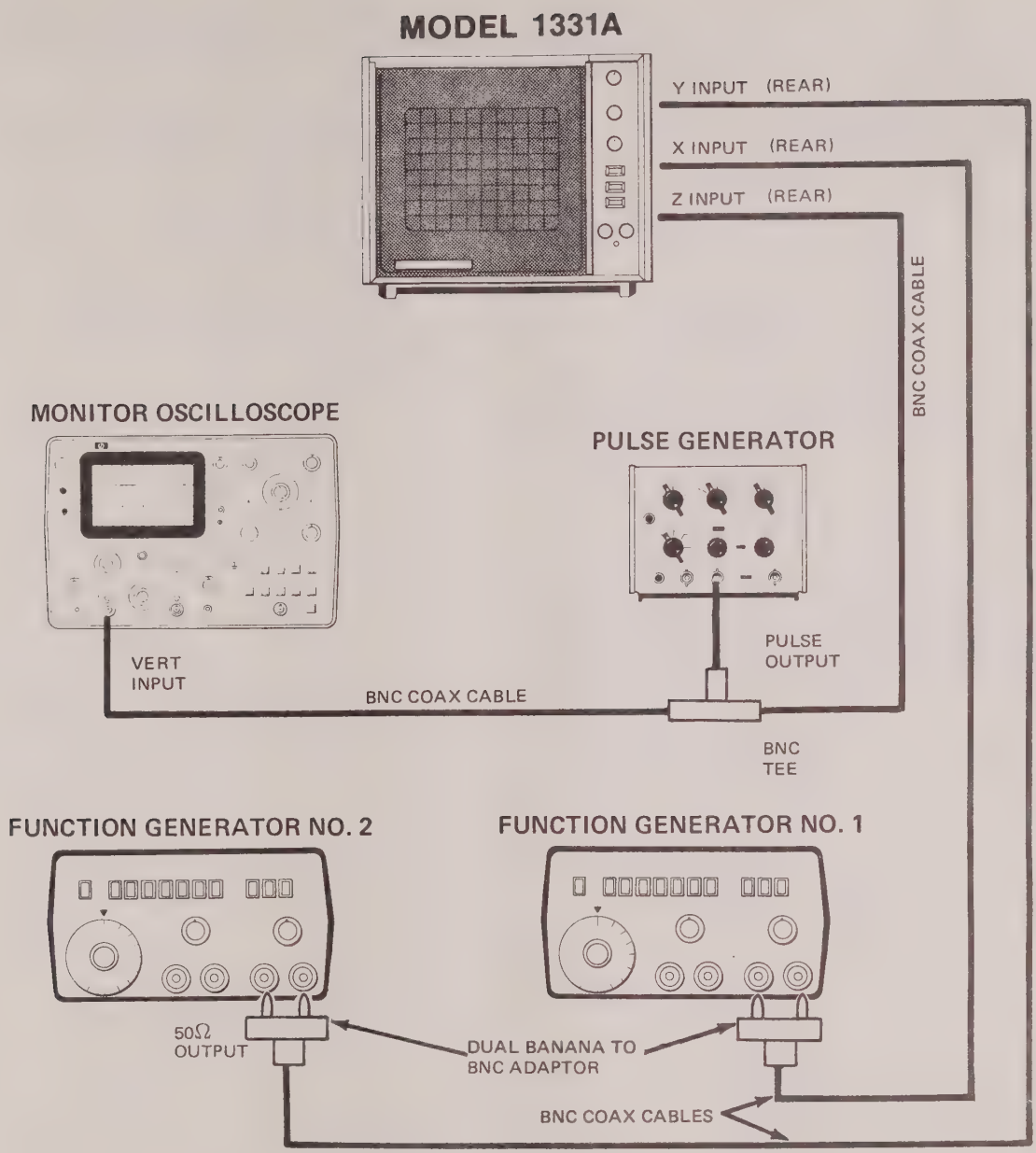


Figure 5-4. Variable Persistence Function

c. Set frequency of function generator no. 1 to 4 kHz.

d. Set frequency of function generator no. 2 to 70 Hz.

e. Set PERSISTENCE ccw.

f. Press WRITE pushbutton.

g. Set amplitudes of function generators and Model 1331A POSITION controls to achieve centered 7 x 9 division raster display on CRT.

h. Connect monitor oscilloscope to output of pulse generator.

i. Set pulse generator for positive, 1V p-p, us width, 1-kHz pulse as displayed on monitor oscilloscope.

j. Disconnect monitor oscilloscope and connect output of pulse generator to Z INPUT.

k. Adjust the amplitude controls on both triangle wave generators for exactly 7 x 9 division display. If line structure is visible in pattern, shift frequency of the 4 kHz triangle-wave generator slightly.

l. Set FOCUS and ASTIG for best dot resolution over 7 x 9 division area.

m. Set pulse generator polarity switch to negative.

n. Set PERSISTENCE cw.

o. Press and release ERASE pushbutton.

p. Set pulse generator polarity switch to positive, then back to negative. Dot pattern shall appear and remain visible over entire 7 x 9 division area, with no fade positive or fade negative for 60 seconds or longer.

q. Press and release ERASE pushbutton.

r. Set pulse generator polarity switch to positive, then back to negative and immediately press STORE pushbutton. Dot pattern shall appear and remain visible over entire 7 x 9 division area, with no fade positive or fade negative, for 15 minutes or more.

s. Press and release ERASE pushbutton.

t. Set pulse generator to positive, then back to negative. When dot pattern appears, immediately press and release ERASE pushbutton. Erasure shall be complete.

u. Connect monitor oscilloscope to CRT storage mesh, write/green wire (95) on main board A1 (figure 5-10, reference point 11).

v. Set monitor oscilloscope to observe a one-shot, one second occurence.

w. Press and release ERASE pushbutton. Compare displayed pattern with figure 5-5. Time T shall be 500 milliseconds or less.

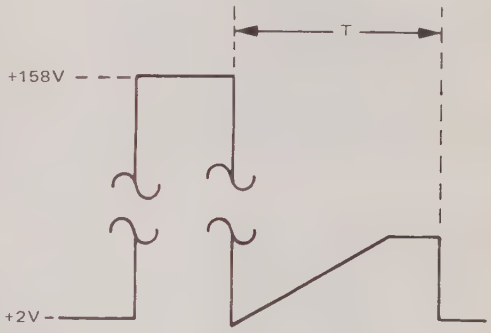


Figure 5-5. Erase Waveform

PERFORMANCE CHECK RECORD

MODEL 1331A

Instrument Serial Number _____ Date _____

Check	Specification	Measured
DEFLECTION		
X Input	10 div ±3%	_____
Y Input	8 div ±3%	_____
BANDWIDTH		
X Amplifier	>7.1 div	_____
Y Amplifier	>5.7 div	_____
PHASE SHIFT		
500 kHz	<0.17 div	_____
COMMON MODE REJECTION RATIO		
X Input	<1.2 minor div	_____
Y Input	<1.5 minor div	_____
SETTLING TIME	<1 us	_____
Z AXIS BANDWIDTH	>4.2 div	_____
Z AXIS RISE TIME	≤70 ns	_____
VARIABLE PERSISTENCE FUNCTION		
Persistence	>60 seconds	_____
Store	>15 minutes	_____

5-25. ADJUSTMENTS.

WARNING

Do not attempt to perform adjustment procedures until the safety summary, located just before Section I, has been read and understood.

5-26. The following paragraphs describe procedures to calibrate the instrument so it will perform as specified in table 1-1. For complete calibration, the entire procedure should be performed in sequence. Individual adjustments can be made by following the steps in the appropriate paragraphs. Adjustment locations are shown in figures 5-10 through 5-13.

5-27. Read the introduction to this section. Remove covers before connecting instrument for operation. Turn instrument on and allow 1/2 hour warmup time. After adjustments are completed, check instrument by accomplishing the performance checks described earlier in this section.

5-28. LOW-VOLTAGE POWER SUPPLY ADJUSTMENTS. (See table 5-1, figures 5-10, 5-13 and schematic 5).

5-29. Perform low-voltage power supply adjustments as follows:

a. Connect voltmeter through 1:1 probe to output of —50V supply, violet wire (7) on main board A1, (figure 5-10, reference point 8).

b. Set —50V Adj A8R22 for reading of —50V ±.02V on voltmeter (figure 5-13).

c. Connect voltmeter to output of +50V supply, white/red wire (92) on main board A1, (figure 5-10, reference point 7).

d. Connect voltmeter to output of +158V power supply, red wire (2) on main board A1, (figure 5-10, reference point 6). Output shall be +158V ±4V.

e. Connect voltmeter to output of +12.6V power supply, white/black/red wire (902) on main board A1, (figure 5-10, reference point 13).

f. Set +12.6V Adj A1R160 for reading +12.6V ±.1V on voltmeter (figure 5-10, reference point 1).

5-30. HIGH-VOLTAGE POWER SUPPLY ADJUSTMENT. (See table 5-1, figures 5-10, 5-11, and schematic 4.)

5-31. Perform high-voltage power supply adjustments as follows:

WARNING

Voltages capable of causing injury or death are present in the high-voltage power supply. Use an insulated adjustment tool and proceed carefully.

a. Connect voltmeter through 1000:1 probe to output of —50V power supply, violet wire (7) on main board A1 (figure 5-10, reference point 8).

b. Multiply voltage reading from step a by 58.3.

c. Connect 1000:1 probe to cathode output of high-voltage supply, yellow wire (4) on board A2 (figure 5-11, reference point 2).

d. Set HV Adj A2R33 for voltage reading equal to result in step b (figure 5-11, reference point 5).

5-32. INTENSITY LIMIT ADJUSTMENT. (See table 5-1, figure 5-1, and schematic 4).

5-33. Perform intensity limit adjustments as follows:

A. Set HORIZ POSITION, VERT POSITION, and INTENSITY to display dot in center of CRT screen.

b. Connect voltmeter through 1:1 probe to output of gate amplifier, white/black/orange wire (903) on board A2 (figure 5-11, reference point 3).

c. Set INTENSITY for +7V reading on voltmeter.

d. Set PERSISTENCE ccw.

e. Set Intensity Limit Adj A2R38 to just extinguish spot on CRT (figure 5-11, reference point 6).

f. Set PERSISTENCE cw and observe screen for 60 seconds. If spot reappears, press ERASE button and reset Intensity Limit Adj A2R38 slightly cw, observe again for 60 seconds.

5-34. X- AND Y-GAIN ADJUSTMENTS. (See table 5-1, figure 5-10, and schematic 1).

5-35. Perform x- and y-gain adjustments as follows:

a. Set voltmeter calibrator for 1V p-p, 400-Hz output.

b. Connect output of voltmeter calibrator to Y INPUT.

c. Set Y GAIN A1R18 for vertical trace length of exactly 8 divisions (figure 5-10, reference point 4).

d. Connect output of voltmeter calibrator to X INPUT.

e. Set X Gain A1R48 for horizontal trace length of exactly 10 divisions (figure 5-10, reference point 3).

5-36. PHASE-SHIFT ADJUSTMENT. (See table 5-1, figures 5-6, 5-7, 5-10, and schematic 1).

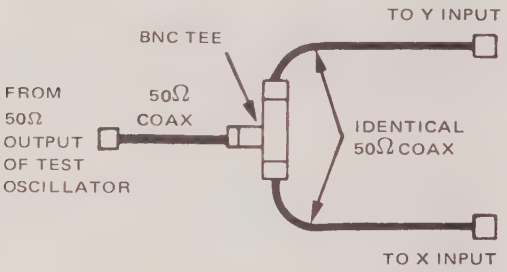


Figure 5-6. Phase Shift Test Setup

5-37. Perform phase shift adjustments as follows:

a. Connect equipment as indicated in figure 5-6.

b. Set test oscillator for 1V p-p, 500-kHz output.

c. Observe ellipse on CRT screen (figure 5-7).

d. Set Phase Adj A1C7 (figure 5-10, reference point 5) for minimum opening of ellipse (straight line possible). Opening shall not exceed 0.17 division.

5-38. Z-AXIS ADJUSTMENTS. (See table 5-1, figure 5-11, and schematic 4).

5-39. Perform the z-axis adjustments as follows:

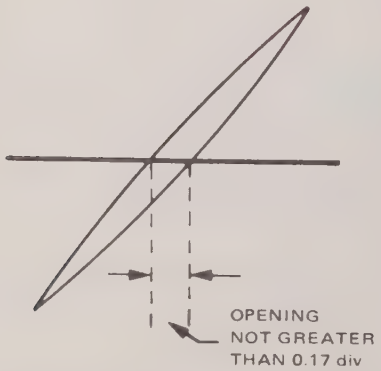


Figure 5-7. Phase Shift Display

a. Connect a 1V p-p, 1-kHz signal to the X INPUT.

b. Connect a 1V p-p, 1-kHz signal to the Y INPUT.

c. Connect monitor oscilloscope through 10:1 probe to output of gate amplifier, white/black/orange wire (903) on board A2 (figure 5-11, reference point 3).

d. Connect 100-kHz positive output of pulse generator to Z INPUT.

e. Set amplitude amplitude of pulse generator for 25V positive pulse as displayed on monitor oscilloscope, and set INTENSITY control of Model 1331A for pulse baseline of ≈+7V dc.

f. Set Int Gate BW Adj A2C3 for <60 ns rise and fall times on pulse. Measure between 10% and 90% points.

g. Observe leading edge of pulse. Overshoot shall not exceed 3%.

h. Disconnect pulse generator.

i. Center INTENSITY control.

j. Connect 50-kHz signal from 50Ω output of test oscillator to Z INPUT.

k. Set amplitude of test oscillator for 25V p-p signal as displayed on monitor oscilloscope. There shall be no rounding or clipping of waveform (readjust INTENSITY as necessary).

l. Adjust monitor oscilloscope for 6-division vertical display.

m. Increase frequency of test oscillator to 5 MHz and level the oscillator output using its front-panel meter. Display on monitor oscilloscope shall be equal to or greater than 4.2 divisions.

n. Turn Model 1331A off, and turn INTENSITY control ccw.

5-40. COLLIMATION ADJUSTMENTS. (See table 5-1, figures 5-8, 5-10, and schematic 3).

5-41. Perform collimator adjustments as follows:

a. Disconnect all inputs.

b. Set INTENSITY and PERSISTENCE ccw.

c. Press WRITE pushbutton.

d. Press and release ERASE pushbutton.

e. Set Coll Adj A1R145 to overcollimate flood gun beam, (figure 5-10 reference point 9).

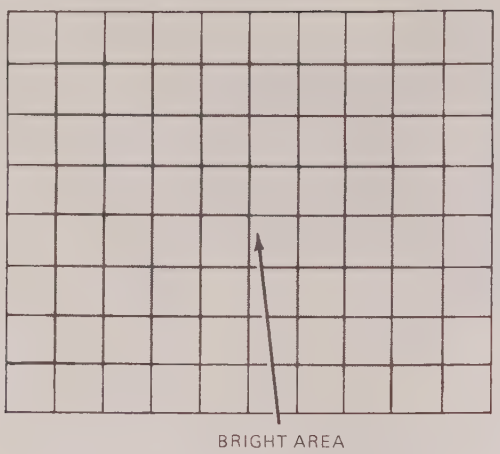


Figure 5-8. Overcollimated CRT

f. Start with Flood Gun Grid Adj A1R129 fully ccw, (figure 5-10, reference point 10), and slowly adjust clockwise until the first initial rapid increase in pattern brightness is passed. The background will first increase rapidly, then increase more slowly, then decrease (starting at the edges). Set potentiometer at point of transition from rapid increase to increasing more slowly in pattern brightness.

g. Reset Coll Adj A1R145 until bright green area just fills 8 x 10 graticule outline on CRT, (figure 5-8). Adjust, so that dimple in the worst corner intrudes into the graticule area exactly 0.1 major division, (provides the best writing speed uniformity).

5-42. VARIABLE PERSISTENCE STORAGE FUNCTION ADJUSTMENTS. (See table 5-1, figures 5-9, 5-10, and schematics 2, and 3).

5-43. Perform variable persistence storage fucntion adjustments as follows:

a. Connect equipment as shown in figure 5-9. Note that output of pulse generator is not yet connected to Z INPUT.

b. Set function switches on both function generators to triangle function.

c. Set frequency of function generator no. 1 to 4 kHz.

d. Set frequency of function generator no. 2 to 70 Hz.

e. Set PERSISTENCE ccw.

f. Set amplitudes of function generators and Model 1331A POSITION controls to achieve centered 7 x 9 division raster display on CRT.

g. Connect output of pulse generator to Z INPUT.

h. Set pulse generator for positive, 1V p-p, 2 us width, 1 kHz pulse output.

i. Set INTENSITY ccw. Dot pattern covering 7 x 9 division area shall appear. If line structure is apparent in pattern, readjust 4 kHz frequency of function generator no. 1 slightly.

j. Set FOCUS and ASTIG for optimum dot size and shape over 7 x 9 area.

k. Set pulse generator polarity switch to negative.

l. Set PERSISTENCE cw.

m. Press and release ERASE pushbutton.

n. Set Write Depth Adj A1R82 ccw (figure 5-10, reference point 2).

o. While pressing and releasing ERASE pushbutton, adjust write depth A1R82 cw until no green areas are visible inside 8 x 10 div graticule area.

NOTE

Up to three light, dim spots are acceptable as long as they do not fade positive within 60 seconds, and if they are less bright than area written by the beam.

p. Set pulse generator polarity switch to positive, then back to negative. Dots shall appear and remain visible for at least 60 seconds with no fade positive or fade negative.

NOTE

If dots fade negatively or background fades positively, a small readjustment of Write Depth Adj A1R82 may be required. If the dots near the top and bottom edges of the screen rapidly fade negative, it may be necessary to set Coll Adj A1R45 slightly ccw. Flood Gun Grid Adj A1R19 or Coll Adj A1R145 or both may require slight readjustment to meet the 60 second requirement in step p.

q. Connect monitor oscilloscope probe to flood gun accelerator, white/black/blue wire on board A1 (figure 5-10, reference point 12).

r. Press STORE pushbutton.

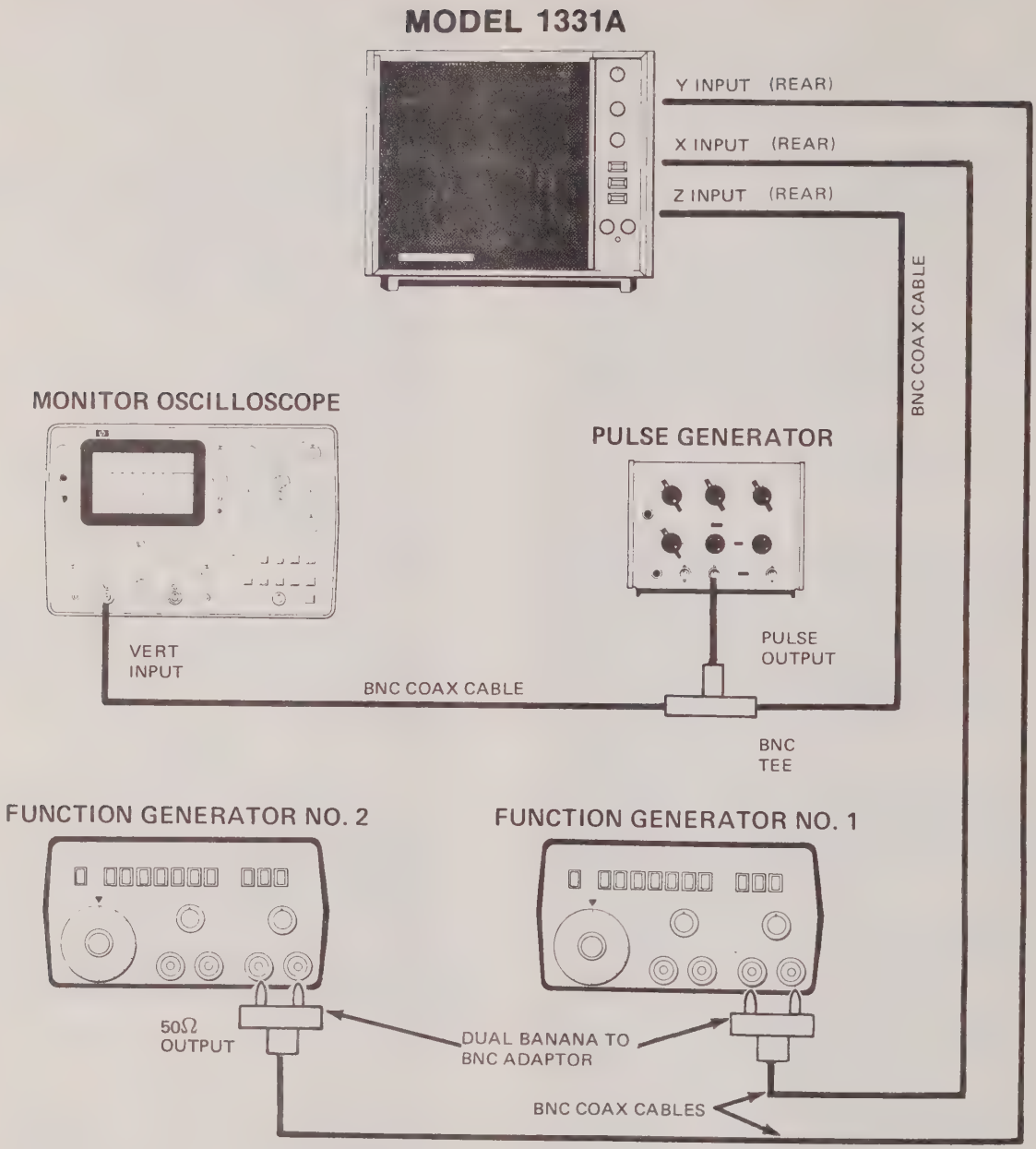


Figure 5-9. Storage Function Adjust Setup

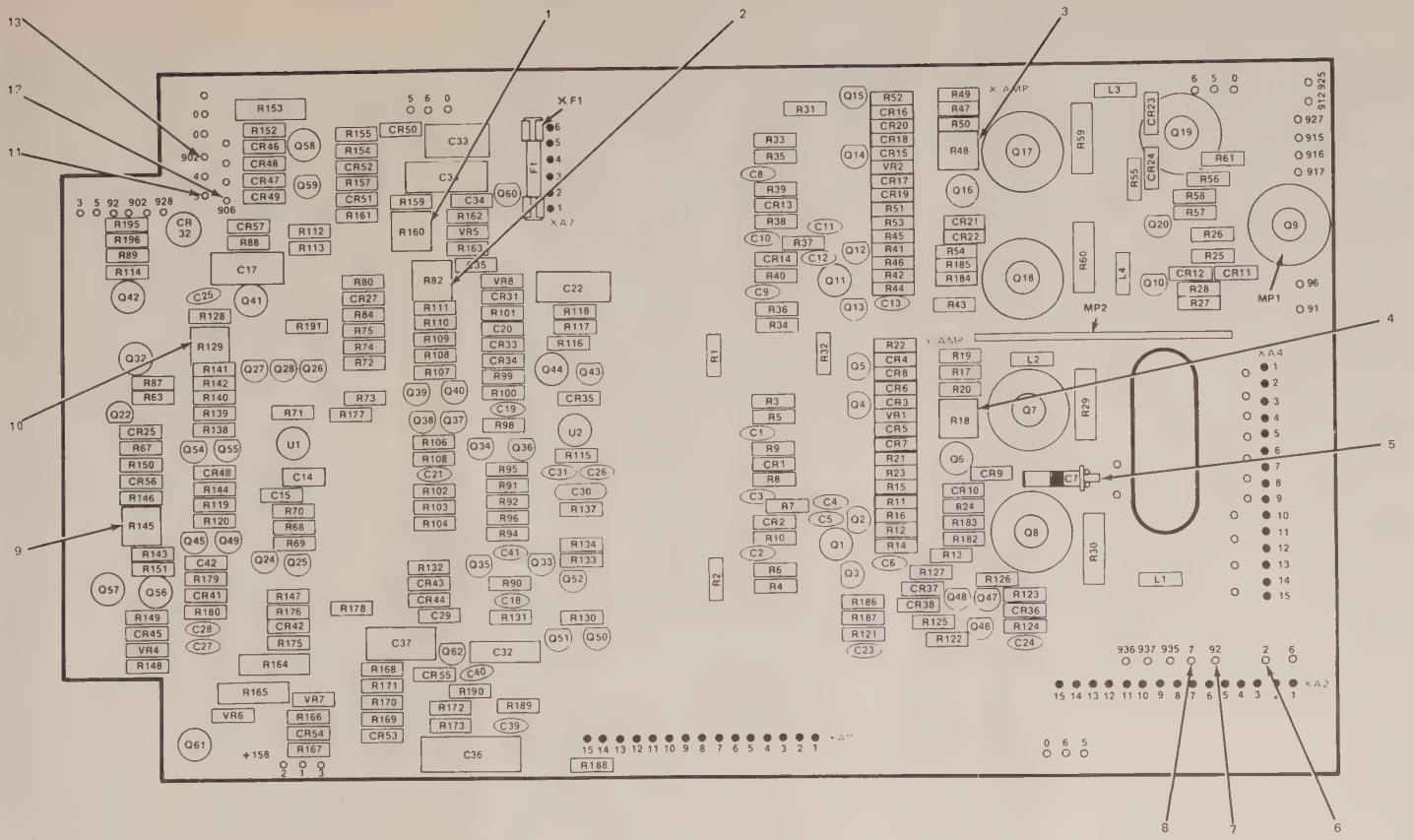
s. Adjust monitor oscilloscope so that one pulse occupies 1 horizontal division on CRT with leading edge at left edge of graticule.

t. Set STORE TIME ADJ A4R26 (figure 5-12) to place leading edge of adjacent pulse on right edge of graticule (10% duty cycle).

u. Press write pushbutton.

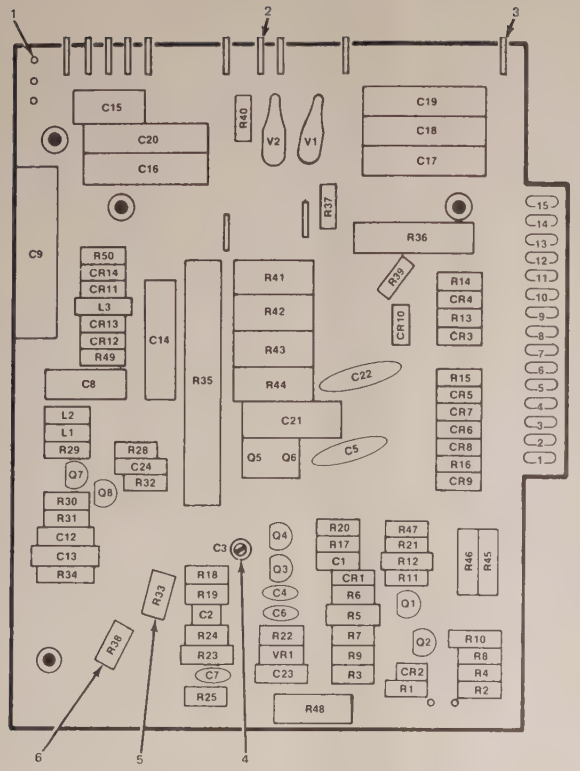
v. Press and release ERASE pushbutton.

w. Set pulse generator polarity switch to positive, then back to negative and immediately press STORE pushbutton. Stored pattern shall remain visible for 15 minutes or more. Brightness of stored pattern is approximately one half that of write pattern.



1. +12.6V ADJ.
2. WRITE DEPTH ADJ.
3. X GAIN ADJ.
4. Y GAIN ADJ.
5. PHASE ADJ.
6. +158V Monitor Point, Red Wire (2).
7. +50V Monitor Point, White/Brown Wire (92).
8. —50V Monitor Point, Violet Wire (7).
9. COLLIMATOR ADJ.
10. FLOOD GUN GRID ADJ.
11. CRT STORAGE MESH VOLTAGE Monitor Point, White/Green Wire (95).
12. CRT FLOOD GUN ACCELLERATOR VOLTAGE Monitor Point, White/Black/Blue Wire (906).
13. +12.6V Monitor Point, White/Black/Red Wire (902).

Figure 5-10.
Adjustment and Test Point Monitor Locations on A1



1. HIGH VOLTAGE POWER SUPPLY Disconnect Point, Blue Wire (6).
2. CRT WRITE GUN CATHODE VOLTAGE Monitor Point, Yellow Wire (4).
3. GATE AMPLIFIER OUTPUT Monitor Point, White/Black/Orange Wire (903).
4. INTENSITY GATE BW ADJ.
5. HIGH VOLTAGE ADJ.
6. INTENSITY LIMIT ADJ.

Figure 5-11. Adjustment, and Test Point Monitor Locations on A2

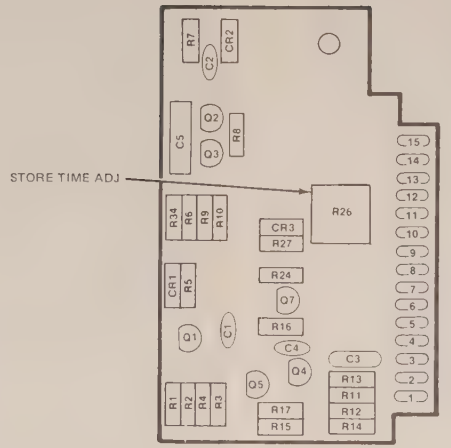


Figure 5-12. Adjustment Locations on A4

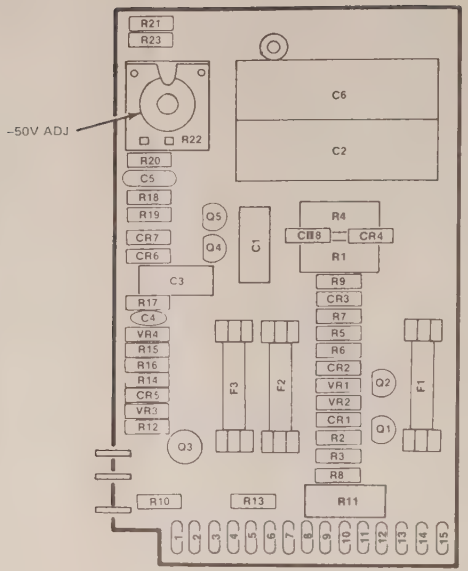


Figure 5-13. Adjustment Locations on A8

SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. The abbreviations used in the parts list are described in table 6-1. Table 6-2 lists the parts in alphanumeric order by reference designation and includes the manufacturer and manufacturer's part number. Table 6-3 contains the list of manufacturers' codes. See figure 6-1 for an illustrated parts breakdown of the Model 1331A.

6-3. ORDERING INFORMATION.

6-4. To obtain replacement parts from Hewlett-Packard, address order or inquiry to the nearest Hewlett-Packard Sales/Service Office and supply the following information:

a. Instrument model and serial number.

b. HP part number of item(s).

c. Quantity of part(s) desired.

d. Reference designator of part(s).

6-5. To order a part not listed in the table, provide the following information:

a. Instrument model and serial number.

b. Description of the part, including function and location in the instrument.

c. Quantity desired.

Table 6-1. Abbreviations for Replaceable Parts List

A	AMPERE(S)	H	HENRY(IES)	NPN	NEGATIVE-POSITIVE-NEGATIVE	RWV	REVERSE WORKING VOLTAGE
ASSY	ASSEMBLY	HG	MERCURY				
		HP	HEWLETT-PACKARD	NSR	NOT SEPARATELY REPLACEABLE	S-B	SLOW-BLOW
BD	BOARD(S)	HZ	HERTZ			SCR	SILICON CONTROLLED RECTIFIER
BH	BINDER HEAD						
BP	BANDPASS	IF	INTERMEDIATE FREQ.	OBD	ORDER BY DESCRIPTION	SE	SELENIUM
		IMPG	IMPREGNATED			SEC	SECOND(S)
C	CENTI (10^{-2})	INCD	INCANDESCENT	OH	OVAL HEAD	SECT	SECTION(S)
CAR	CARBON	INCL	INCLUDE(S)	OX	OXIDE	SI	SILICON
CCW	COUNTERCLOCKWISE	INS	INSULATION(ED)			SIL	SILVER
CER	CERAMIC	INT	INTERNAL	P	PEAK	SL	SLIDE
CMO	CABINET MOUNT ONLY			PC	PRINTED (ETCHED) CIRCUIT(S)	SP	SINGLE POLE
COAX	COAXIAL	K	KILO (10^{3})			SPL	SPECIAL
COEF	COEFFICIENT	KG	KILOGRAM	PF	PICOFARADS	ST	SINGLE THROW
COMP	COMPOSITION			PHL	PHILLIPS	STD	STANDARD
CONN	CONNECTOR(S)	LB	POUND(S)	PIV	PEAK INVERSE VOLTAGE(S)		
CRT	CATHODE-RAY TUBE	LH	LEFT HAND			TA	TANTALUM
CW	CLOCKWISE	LIN	LINEAR TAPER	PNP	POSITIVE-NEGATIVE-POSITIVE	TD	TIME DELAY
		LOG	LOGARITHMIC TAPER			TFL	TEFLON
D	DECI (10^{-1})	LPF	LOW-PASS FILTER(S)	P/O	PART OF	TGL	TOGGLE
DEPC	DEPOSITED CARBON	LVR	LEVER	PORC	PORCELAIN	THYR	THYRISTOR
DP	DOUBLE POLE			POS	POSITION(S)	TI	TITANIUM
DT	DOUBLE THROW	M	MILLI (10^{-3})	POT	POTENTIOMETER(S)	TNLDIO	TUNNEL DIODE(S)
		MEG	MEGA (10^{6})	P-P	PEAK-TO-PEAK	TOL	TOLERANCE
ELECT	ELECTROLYTIC	MET FILM	METAL FILM	PRGM	PROGRAM	TRIM	TRIMMER
ENCAP	ENCAPSULATED	MET OX	METAL OXIDE	PS	POLYSTYRENE		
EXT	EXTERNAL	MFR	MANUFACTURER	PWV	PEAK WORKING VOLTAGE	U	MICRO (10^{-6})
		MINAT	MINIATURE				
F	FARAD(S)	MOM	MOMENTARY			V	VOLTS
FET	FIELD-EFFECT TRANSISTOR(S)	MTG	MOUNTING	RECT	RECTIFIER(S)	VAR	VARIABLE
		MY	MYLAR	RF	RADIO FREQUENCY	VDCW	DC WORKING VOLT(S)
FH	FLAT HEAD			RFI	RADIO FREQUENCY INTERFERENCE		
FIL H	FILLISTER HEAD	N	NANO (10^{-9})			W	WATT(S)
FXD	FIXED	N/C	NORMALLY CLOSED	RH	ROUND HEAD OR RIGHT HAND	W/	WITH
		NE	NEON			WIV	WORKING INVERSE VOLTAGE
G	GIGA (10^{9})	N/O	NORMALLY OPEN				
GE	GERMANIUM	NOP	NEGATIVE POSITIVE ZERO (ZERO TEMPERATURE COEFFICIENT)	RMO	RACK MOUNT ONLY	W/O	WITHOUT
GL	GLASS			RMS	ROOT MEAN SQUARE	WW	WIREWOUND
GRD	GROUNDED						

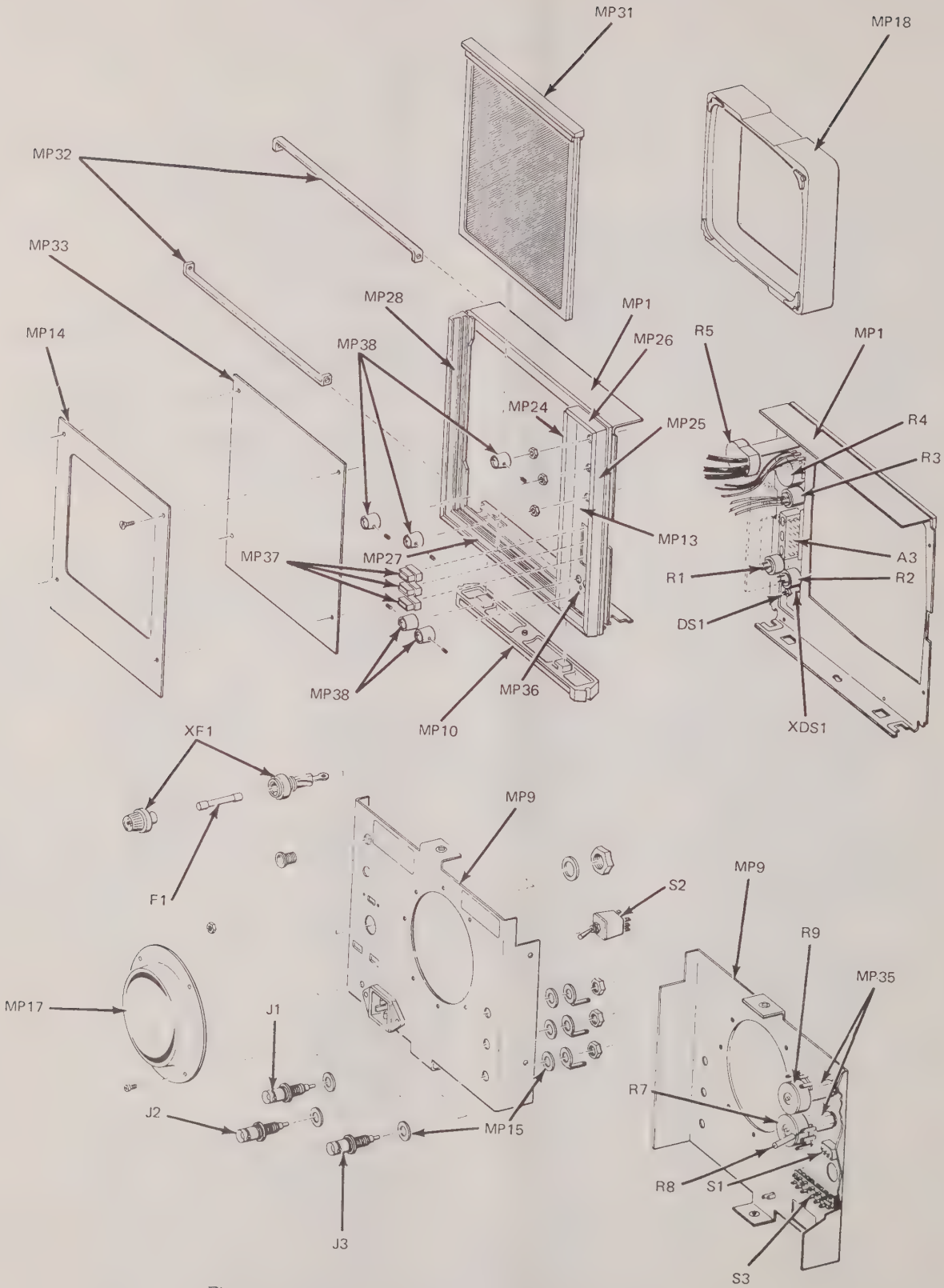


Figure 6-1. Model 1331A Illustrated Parts Breakdown (Sheet 1 of 2)

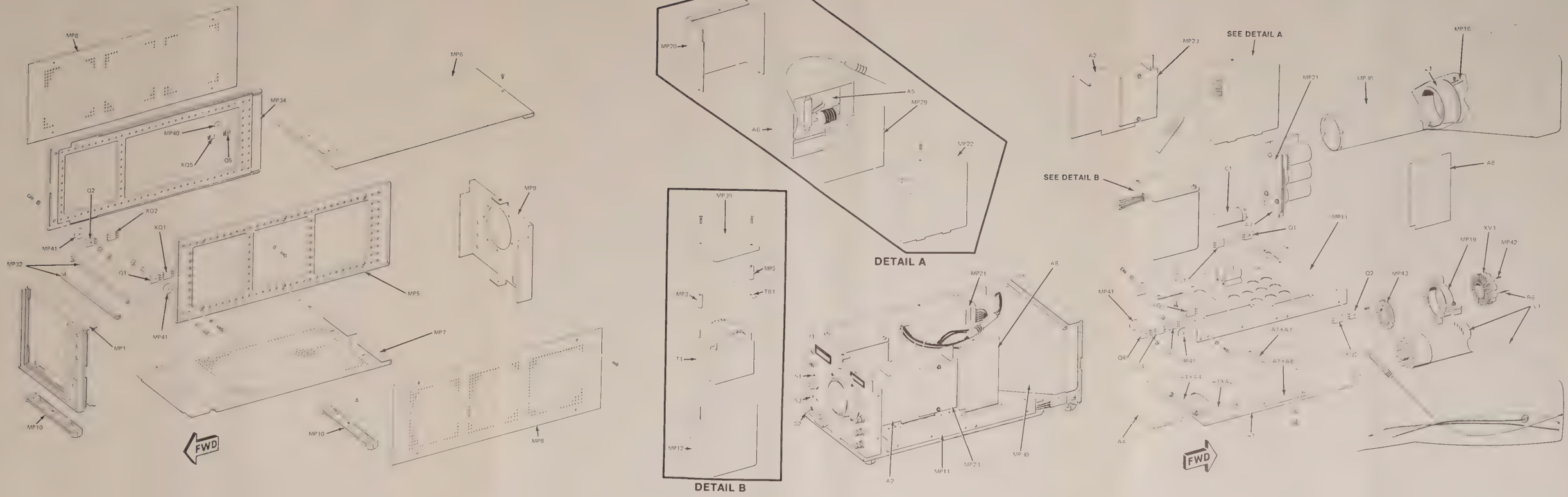


Figure 6-1.
Model 1331A Illustrated Parts Breakdown (Sheet 2 of 2)
6-3/(6-4 blank)

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	01331 66530	1	MAIN BOARD ASSY	28480	01331-66530
A2	01331-66533	1	Z AMPLIFIER/HIGH VOLTAGE BOARD ASSY	28480	01331-36533
A3	01331-61903	1	PUSHBUTTON ASSY	28480	01331 61903
A4	01331-66534	1	PROGRAM BOARD ASSY	28480	01331-66534
A5	01201-66510	1	HIGH VOLTAGE RECTIFIER ASSY	28480	01201-66510
A6	01331-61104	1	HIGH VOLTAGE TRIPLER ASSY	28480	01331-61104
A7	01331-66504	1	LOW VOLTAGE RECTIFIER ASSY	28480	01331-66504
A8	01331-66502	1	LOW VOLTAGE POWER SUPPLY ASSY	28480	01331-66502
C1	0180-2157	1	C:FXD ELECT 500UF+100--10% 50VDC W	28480	0180-2157
DS1	2140-0350	1	LAMP:INCAND; BULB TI; 28V	71744	CM 6838
F1	2110-0020	1	FUSE; .8A 250V SLO-BLO (FOR 220,240VAC OPERATION)	71400	MDL 8/10
F1	2110-0059	1	FUSE; 1.5A 125V SLO-BLO (FOR 100,120VAC OPERATION)	75915	31301.5
J1	1250-0118	3	CONNECTOR-COAX; BNC; 50 OHM FEMALE	9D949	31-2221-1022
J2	1250-0118		CONNECTOR-COAX; BNC; 50 OHM FEMALE	9D949	31-2221-1022
J3	1250-0118		CONNECTOR-COAX; BNC; 50 OHM FEMALE	9D949	31-2221-1022
L1	01331-66001	1	COIL ASSY:TRACE ALIGN	28480	01331-66001
MP1	01331-00209	1	PANEL:FRONT	28480	01331-00209
MP2	0380-0392	1	STANDOFF, HEX, FEMALE, 0.875L	06540	8577-A-832-0
MP3	0380-0090	1	STANDOFF, HEX, FEMALE, 1.062L	28480	0380-0090
MP5	5060-0704	1	FRAME ASSY:6 X 16 SM	28480	5060-0704
MP6	01331-04112	1	COVER:TOP	28480	01331-04112
MP7	01331-04107	1	COVER:BOTTOM	28480	01331-04107
MP8	01331-04109	2	COVER:SIDE	28480	01331-04109
MP9	01331-00212	1	PANEL:REAR	28480	01331-00212
MP10	5060-0728	2	FOOT ASSY:HALF MODULE	28480	5060-0728
MP11	01331-00101	1	DECK:MAIN	28480	01331-00101
MP12	01331-05501	1	CAN-RECTANGULAR	28480	01331-05501
MP13	01331-00215	1	PANEL:RECESSED	28480	01331-00215
MP14	01331-02201	1	BEZEL:CRT	28480	01331-02201
MP15	5040-0702	6	INSULATOR:CONNECTOR	28480	5040-0702
MP16	00180-01218	2	BRACKET:ALIGNMENT COIL	28480	00180-01218
MP17	00851-0008	1	COVER:SOCKET	28480	00851-0008
MP18	01200-44701	1	SUPPORT:CRT	28480	01200-44701
MP19	01200-44703	1	SUPPORT:CRT SHIELD	28480	01200-44703
MP20	01331-00601	1	SHIELD:HIGH VOLTAGE POWER SUPPLY	28480	01331-00601
MP21	01331-01202	1	BRACKET:RECTIFIER-CAPACITOR	28480	01331-01202
MP22	01331-04111	1	COVER:HIGH VOLTAGE TRIPLER ASSY	28480	01331-04111
MP23	01331-00604	1	SHIELD:POWER SUPPLY	28480	01331-00604
MP24	5020-0577	1	BEZEL:DIVIDER	28480	5020-0577
MP25	01331-22203	1	BEZEL:RIGHT SIDE	28480	01331-22203
MP26	5020-0578	1	BEZEL:TOP	28480	5020-0578
MP27	5020-0579	1	BEZEL:BOTTOM	28480	5020-0579
MP28	5020 0580	1	BEZEL:LEFT SIDE	28480	5020-0580
MP29	01331-25401	1	INSULATOR:CP	28480	01331-25401
MP30	01331-60602	1	SHIELD:CATHODE RAY TUBE	28480	01331-60601
MP31	5060-0591	1	SCREEN ASSY, CONTRAST	28480	5060-0591
MP32	01331-04701	2	SPACER:CABINET	28480	01331-04701
MP33	01331-02701	1	SHIELD, CLEAR PROTECTIVE	28480	01331-02701
MP34	01331-20501	1	FRAME:LEFT	28480	01331-20501
MP35	1401-0052	2	BUSHING, PANEL, 3/8-32 THD BRASS	28480	1401-0052
MP36	1450-0404	1	LENS:CLEAR	28480	1450-0404
MP37	0370-0451	3	BEZEL:PUSHBUTTON KNOB BLK NYLON	28480	0370-0451
MP38	00183-67407	5	KNOB ASSY:BLANK	50439	00183-67407
MP39	01331-04110	1	COVER:TRANSFORMER	28480	01331-04110
MP40	0340-0451	1	INSULATOR, TRANSISTOR	34344	14B52600F03
MP41	0340-0450	4	INSULATOR, TRANSISTOR	91500	14BSB52600F13
MP42	1200 0050	8	CONTACT-CRT SOCKET	72857	9553 1
MP43	1200-0408	1	COVER-CRT SOCKET	28480	1200-0408
Q1	1854-0320	2	TRANSISTOR:QN S X 58 HP SPEC	28480	1854-0320
Q2	5080-0484	1	TRANSISTOR:	28480	5080-0484
Q3	1853-0079	1	TRANSISTOR:QP S PWR HP SPEC	02753	2N3439
Q4	1854-0320		TRANSISTOR:QN S X--58 HP SPEC	28480	1854-0320
Q5	1854-0330	1	TRANSISTOR:QN S X--58 HP SPEC	28480	1854-0330
R1	2100-2806	2	RESISTOR:VAR; CONT; 2.5K 20% CC	01121	TYPE W
R2	2100-2806		RESISTOR:VAR; CONT; 2.5K 20% CC	01121	TYPE W
R3	2100-2635	1	RESISTOR:VAR; CONT; 50K 20% CC	01121	TYPE W
R4	2100-2757	1	RESISTOR:VAR; CONT; 5K 20% C	72825	TYPE 551
R5	2100-2563	1	RESISTOR:VAR; CONT; 5M 20% CC	28480	2100-2563
R6	0684-1041	1	RESISTOR-FXD 100K 10% 0.25W CC	01121	CB1041
R7	2100-0823	1	RESISTOR:VAR; CONT; 250K 20% CC	71590	MODEL 2
R8	0687-5631	1	REISITOR:FXD 56K 10% .5W CC TUBULAR	01121	EB5631
R9	2100-0013	1	RESISTOR:VAR;CONT; 50K 20% CC	12697	SERIES 47
S2	3101-1732	1	SWITCH:TGL; DPDT 2A/250 VAC ON--NONE--ON	28480	3101-1732

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
T1	9100-0589	1	TRANSFORMER; POWER 5SEC	28480	9100-0589
TB1	01200-67501	1	TERMINAL BOARD:TRANSFORMER	28480	01200-67501
V1	5083-2591	1	CATHODE RAY TUBE	28480	5083-2591
W1	01331-61619	1	CABLE:COAXIAL	28480	01331-61619
W2	01331-61620	1	CABLE:COAXIAL	28480	01331-61620
W3	01331-61622	1	CABLE:OUTPUT	28480	01331-61622
W4	01331-61621	1	CABLE:OUTPUT	28480	01331-61621
W5	01331-61614	1	CABLE:COAX	28480	01331-61614
W6	8120-1395	1	CABLE, UNSHLD 3-COND 18AWG	70903	KH-7077
W7	01331-61625	1	CABLE, MAIN	28480	01331-61625
W8	01331-61628	1	CABLE, HV	28480	01331-61628
W9	01331-61609	1	CABLE:CAPACITOR	28480	01331-61609
XDS1	00183-67701	1	BASE: PILOT LIGHT	28480	00183-67701
XF1	1400-0084	1	FUSEHOLDER; EXTR POST; BAY CAP; 15A	28480	1400-0084
XQ1	5060-0585	3	CABLE-TRANSISTOR CONN	28480	5060-0585
XQ2	5060-0584	1	CABLE-TRANSISTOR CONN	28480	5060-0584
XQ3	5060-0585		CABLE-TRANSISTOR CONN	28480	5060-0585
XQ4	5060-0585		CABLE-TRANSISTOR CONN	28480	5060-0583
XQ5	5060-0583	1	CABLE-TRANSISTOR CONN	28480	5060-0583
XV1	1200-0037	1	CRT SOCKET	28480	1200-0037

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1					
A1	01331-66530	1	MAIN BOARD ASSY	28480	01331-66530
A1					
A1					
A1C1	0160-3451	8	CAPACITOR-FXD .01UF+80-20% 100WVDC	28480	0160-3451
A1C2	0160-3451		CAPACITOR-FXD .01UF+80-20% 100WVDC	28480	0160-3451
A1C3	0160-3443	4	CAPACITOR-FXD .1UF+80-20% 50WVDC	28480	0160-3443
A1C4	0140-0208	4	CAPACITOR-FXD 680PF+-5% 300WVDC	72136	DM15F681J0300WV1CR
A1C5	0140-0208		CAPACITOR-FXD 680PF+-5% 300WVDC	72136	DM15F681J0300WV1CR
A1C6	0160-3443		CAPACITOR-FXD .1UF+80-20% 50WVDC	28480	0160-3443
A1C7	0121-0407	1	CAPACITOR, VAR, TRMR, PSTN, .7/3PF	72982	536-016
A1C8	0160-3451		CAPACITOR-FXD .01UF+80-20% 100WVDC	28480	0160-3451
A1C9	0160-3451		CAPACITOR-FXD .01UF+80-20% 100WVDC	28480	0160-3451
A1C10	0160-3443		CAPACITOR-FXD .1UF+80-20% 50WVDC	28480	0160-3443
A1C11	0140-0208		CAPACITOR-FXD 680PF+-5% 300WVDC	72136	DM15F681J0300WV1CR
A1C12	0140-0208		CAPACITOR-FXD 680PF+-5% 300WVDC	72136	DM15F681J0300WV1CR
A1C13	0160-3443		CAPACITOR-FXD .1UF+80-20% 50WVDC	28480	0160-3443
A1C14	0160-0207	2	CAPACITOR-FXD .01UF+-5% 200WVDC	56289	292P10352
A1C15	0160-3451		CAPACITOR-FXD .01UF+80-20% 100WVDC	28480	0160-3451
A1C17	0160-0168	3	CAPACITOR-FXD .1UF+-10% 200WVDC	56289	292P10492
A1C18	0140-0206	1	CAPACITOR-FXD 270PF+-5% 500WVDC	72136	DM15F271J0500WV1CR
A1C19	0160-2150	2	CAPACITOR-FXD 33PF+-5% 300WVDC	28480	0160-2150
A1C20	0160-0258	1	CAPACITOR-FXD .0015UF+-10% 200WVDC	56289	292P15292
A1C21	0140-0154	1	CAPACITOR-FXD .0013UF+-5% 500WVDC	72136	DM20F132J0500WV1CR
A1C22	0170-0019	1	CAPACITOR-FXD .1UF+-5% 200WVDC	56289	292P10452
A1C23	0160-2150		CAPACITOR-FXD 33PF+-5% 300WVDC	28480	0160-2150
A1C24	0150-0075	1	CAPACITOR-FXD .0047UF+100-20% 500WVDC	28480	0150-0075
A1C25	0160-3452	3	CAPACITOR-FXD .02UF+-20% 100WVDC	28480	0160-3452
A1C26	0160-3451		CAPACITOR-FXD .01UF+80-20% 100WVDC	28480	0160-3451
A1C27	0160-2210	1	CAPACITOR-FXD 470PF+-5% 300WVDC	28480	0160-2210
A1C28	0160-0156	1	CAPACITOR-FXD .0039UF+-10% 200WVDC	56289	292P39292
A1C29	0180-0197	1	CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1C30	0180-2109	1	CAPACITOR-FXD; 3.3UF+-5% 35VDC TA-SOLID	56289	150D335X503582
A1C31	0160-3451		CAPACITOR-FXD .01UF+80-20% 100WVDC	28480	0160-3451
A1C32	0160-0207		CAPACITOR-FXD .01UF+-5% 200WVDC	56289	292P10352
A1C33	0160-0168		CAPACITOR-FXD .1UF+-10% 200WVDC	56289	292P10492
A1C34	0180-0230	1	CAPACITOR-FXD; 1UF+-20% 50VDC TA-SOLID	56289	150D105X0050A2
A1C35	0160-3451		CAPACITOR-FXD .01UF+80-20% 100WVDC	28480	0160-3451
A1C36	0180-0089	1	CAPACITOR-FXD; 10UF+50-10% 150VDC AL	56289	300106F150002
A1C37	0160-0168		CAPACITOR-FXD .1UF+-10% 200WVDC	56289	292P10492
A1C38	0180-0058	1	CAPACITOR-FXD; 50UF+75-10% 25VDC AL	56289	300506G025CC2
A1C39	0160-3452		CAPACITOR-FXD .02UF+-20% 100WVDC	28480	0160-3452
A1C40	0160-3452		CAPACITOR-FXD .02UF+-20% 100WVDC	28480	0160-3452
A1C41	0160-2204	1	CAPACITOR-FXD 100PF+-5% 300WVDC	28480	0160-2204
A1C42	0160-0134	1	CAPACITOR-FXD 220PF+-5% 300WVDC	28480	0160-0134
A1CR1	1901-0376	5	DIODE; GEN PRP; ; 35V MAX VRM 50MA	28480	1901-0376
A1CR2	1901-0376		DIODE; GEN PRP; ; 35V MAX VRM 50MA	28480	1901-0376
A1CR3	1901-0040	27	DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR4	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR5	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR6	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR7	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR8	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR9	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR10	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR11	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR12	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR13	1901-0376		DIODE; GEN PRP; ; 35V MAX VRM 50MA	28480	1901-0376
A1CR14	1901-0376		DIODE; GEN PRP; ; 35V MAX VRM 50MA	28480	1901-0376
A1CR15	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR16	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR17	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR18	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR19	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR20	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR21	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR22	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR23	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR24	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR25	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR27	1901-0050	2	DIODE; SWITCHING; ; 80V MAX VRM 200MA	28480	1901-0050
A1CR31	1901-0050		DIODE; SWITCHING; ; 80V MAX VRM 200MA	28480	1901-0050
A1CR32	1901-0418	1	DIODE; PWR RECT; ; 400V MAX VRM 1.5A	04713	SR1846-12
A1CR33	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1CR34	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR35	1901-0376		DIODE; GEN PRP; ; 35V MAX VRM 50MA	28480	1901-0376
A1CR36	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR37	1901-0044	1	DIODE; SWITCHING; ; 50V MAX VRM 50MA	28480	1901-0044
A1CR38	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR40	1901-0025	6	DIODE; GEN PRP; ; 100V MAX VRM 200MA	28480	1901-0025
A1CR41	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR42	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR43	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR44	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A1CR45	1901-0025		DIODE; GEN PRP; ; 100V MAX VRM 200MA	28480	1901-0025
A1CR46	1901-0045	4	DIODE; PWR RECT; ; 100V MAX VRM 750MA	28480	1901-0045
A1CR47	1901-0045		DIODE; PWR RECT; ; 100V MAX VRM 750MA	28480	1901-0045
A1CR48	1901-0045		DIODE; PWR RECT; ; 100V MAX VRM 750MA	28480	1901-0045
A1CR49	1901-0045		DIODE; PWR RECT; ; 100V MAX VRM 750MA	28480	1901-0045
A1CR50	1901-0025		DIODE; GEN PRP; ; 100V MAX VRM 200MA	28480	1901-0025
A1CR51	1901-0025		DIODE; GEN PRP; ; 100V MAX VRM 200MA	28480	1901-0025
A1CR52	1901-0025		DIODE; GEN PRP; ; 100V MAX VRM 200MA	28480	1901-0025
A1CR53	1901-0026	3	DIODE; PWR RECT; ; 200V MAX VRM 750MA	04713	SR1358-8
A1CR54	1901-0026		DIODE; PWR RECT; ; 200V MAX VRM 750MA	04713	SR1358-8
A1CR55	1901-0025		DIODE; GEN PRP; ; 100V MAX VRM 200MA	28480	1901-0025
A1CR56	1901-0026		DIODE; PWR RECT; ; 200V MAX VRM 750MA	04713	SR1358-8
A1CR57	1901-0033	1	DIODE; GEN PRP; ; 180V MAX VRM 200MA	28480	1901-0033
A1F1	2110-0001	1	FUSE; 1A 250V	71400	AGC-1
A1L1	9100-1641		COIL; FXD; MOLDED RF CHOKE; 240UH 5%	24226	15/243
A1L2	9100-1641		COIL; FXD; MOLDED RF CHOKE; 240UH 5%	24226	15/243
A1L3	9100-1641		COIL; FXD; MOLDED RF CHOKE; 240UH 5%	24226	15/243
A1L4	9100-1641		COIL; FXD; MOLDED RF CHOKE; 240UH 5%	24226	15/243
A1MP1	1205-0095	6	HEAT-DISSIPATOR, SGL, TO-5 PKG	28480	1205-0095
A1MP2	01331-00602	1	SHIELD	28480	01331-00602
A1Q1	1854-0221	2	TRANSISTOR; BIPOL; SI; NPN DUAL	28480	1854-0221
A1Q2	1854-0071	19	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q3	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q4	1853-0036	6	TRANSISTOR PNP SI CHIP PD=310MW	28480	1853-0036
A1Q5	1853-0036		TRANSISTOR PNP SI CHIP PD=310MW	28480	1853-0036
A1Q6	1854-0475	2	TRANSISTOR; BIPOL; SI; NPN DUAL	28480	1854-0475
A1Q7	1854-0234	8	TRANSISTOR NPN 2N3440 SI PD=1W	02735	2N3440
A1Q8	1854-0234		TRANSISTOR NPN 2N3440 SI PD=1W	02735	2N3440
A1Q9	1854-0022	4	TRANSISTOR NPN SI PD=700MW FT=50MHZ	07263	S17843
A1Q10	1853-0036		TRANSISTOR PNP SI CHIP PD=310MW	28480	1853-0036
A1Q11	1854-0221		TRANSISTOR; BIPOL; SI; NPN DUAL	28480	1854-0221
A1Q12	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q13	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q14	1853-0036		TRANSISTOR PNP SI CHIP PD=310MW	28480	1853-0036
A1Q15	1853-0036		TRANSISTOR PNP SI CHIP PD=310MW	28480	1853-0036
A1Q16	1854-0475		TRANSISTOR; BIPOL; SI; NPN DUAL	28480	1854-0475
A1Q17	1854-0234		TRANSISTOR NPN 2N3440 SI PD=1W	02735	2N3440
A1Q18	1854-0234		TRANSISTOR NPN 2N3440 SI PD=1W	02735	2N3440
A1Q19	1854-0022		TRANSISTOR NPN SI PD=700MW FT=50MHZ	07263	S17843
A1Q20	1853-0036		TRANSISTOR PNP SI CHIP PD=310MW	28480	1853-0036
A1Q22	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q24	1853-0020	1	TRANSISTOR PNP SI CHIP PD=300MW	28480	1853-0020
A1Q25	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q26	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q27	1854-0358	6	TRANSISTOR NPN SI PD=310MW FT=60MHZ	28480	1854-0358
A1Q28	1854-0358		TRANSISTOR NPN SI PD=310MW FT=60MHZ	28480	1854-0358
A1Q32	1854-0234		TRANSISTOR NPN 2N3440 SI PD=1W	02735	2N3440
A1Q33	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q34	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q36	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q37	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q38	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q39	1854-0358		TRANSISTOR NPN SI PD=310MW FT=60MHZ	28480	1854-0358
A1Q40	1853-0080	1	TRANSISTOR PNP SI CHIP PD=300MW	28480	1853-0080
A1Q41	1854-0234		TRANSISTOR NPN 2N3440 SI PD=1W	02735	2N3440
A1Q42	1853-0240	1	TRANSISTOR PNP SI CHIP PD=1W	28480	1853-0240
A1Q43	1854-0548	1	TRANSISTOR NPN 2N5963 SI PD=625MW	07263	2N5963
A1Q44	1854-0234		TRANSISTOR NPN 2N3440 SI PD=1W	02735	2N3440
A1Q45	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q46	1854-0215	2	TRANSISTOR NPN SI PD=310MW FT=300MHZ	04713	SPS 3611
A1Q47	1853-0062	1	TRANSISTOR PNP SI CHIP PD=300MW	28480	1853-0062
A1Q48	1854-0215		TRANSISTOR NPN SI PD=310MW FT=300MHZ	04713	SPS 3611
A1Q49	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q50	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1Q51	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q52	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q54	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q55	1854-0358		TRANSISTOR NPN SI PD=310MW FT=60MHZ	28480	1854-0358
A1Q56	1854-0234		TRANSISTOR NPN 2N3440 SI PD=1W	02735	2N3440
A1Q57	1854-0384	1	TRANSISTOR NPN 2N5184 SI PD=500MW	02735	2N5184
A1Q58	1854-0022		TRANSISTOR NPN SI PD=700MW FT=50MHZ	07263	S17843
A1Q59	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q60	1884-0074	1	THYRISTOR, SCR, JEDEC 2N5060	04713	2N5060
A1Q61	1854-0022		TRANSISTOR NPN SI PD=700MW FT=50MHZ	07263	S17843
A1Q62	1854-0358		TRANSISTOR NPN SI PD=310MW FT=60MHZ	28480	1854-0358
A1R1	C684-0271	9	RESISTOR-FXD 2.7 OHM 10% .25W CC	01121	CB27G1
A1R2	C684-0271		RESISTOR-FXD 2.7 OHM 10% .25W CC	01121	CB27G1
A1R3	C757-0367	2	RESISTOR-FXD 100K 1% .5W F TUBULAR	30983	MF7C1/2-T0-1003-F
A1R4	C687-4701	2	RESISTOR-FXD 47 OHM 10% .5W CC TUBULAR	01121	EB4701
A1R5	C687-1041	4	RESISTOR-FXD 100K 10% .5W CC TUBULAR	01121	EB1041
A1R6	C687-1041		RESISTOR-FXD 100K 10% .5W CC TUBULAR	01121	EB1041
A1R7	C757-0833	4	RESISTOR-FXD 5.11K 1% .5W F TUBULAR	30983	MF7C1/2-T0-5111-F
A1R8	C757-0416	2	RESISTOR-FXD 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A1R9	C687-3321	4	RESISTOR-FXD 3.3K 10% .5W CC TUBULAR	01121	EB3321
A1R10	C687-3321		RESISTOR-FXD 3.3K 10% .5W CC TUBULAR	01121	EB3321
A1R11	C684-2211	5	RESISTOR-FXD 220 OHM 10% .25W CC	01121	CB2211
A1R12	0684-2211		RESISTOR-FXD 220 OHM 10% .25W CC	01121	CB2211
A1R13	0757-0833		RESISTOR-FXD 5.11K 1% .5 WF	30983	MF7C1/2-TO-5111-F
A1R14	0757-0419	2	RESISTOR-FXD 681 1% .125 WF	24546	C4-1/8-TO-681R-F
A1R15	C684-4731	8	RESISTOR-FXD 47K 10% .25W CC TUBULAR	01121	CB4731
A1R16	C684-4731		RESISTOR-FXD 47K 10% .25W CC TUBULAR	01121	CB4731
A1R17	C757-0422	2	RESISTOR-FXD 909 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-909R-F
A1R18	2100-0567	3	RESISTOR, VAR, TRMR, 2KOHM 10% C	73138	72PR2K
A1R19	C69E-3159	4	RESISTOR-FXD 26.1K 1% .125W F TUBULAR	16299	C4-1/8-T0-2612-F
A1R20	C69E-3159		RESISTOR-FXD 26.1K 1% .125W F TUBULAR	16299	C4-1/8-T0-2612-F
A1R21	C69E-0085	4	RESISTOR-FXD 2.61K 1% .125W F TUBULAR	16299	C4-1/8-T0-2611-F
A1R22	C69E-0085		RESISTOR-FXD 2.61K 1% .125W F TUBULAR	16299	C4-1/8-T0-2611-F
A1R23	C757-0749	5	RESISTOR-FXD 6.19K 1% .25W F TUBULAR	24546	C5-1/4-T0-6191-F
A1R24	C757-0413	2	RESISTOR-FXD 392 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-392R-F
A1R25	C757-0834	2	RESISTOR-FXD 5.62K 1% .5W F TUBULAR	30983	MF7C1/2-T0-5621-F
A1R26	0757-0817	2	RESISTOR-FXD 750 1% .5 WF	30983	MF7C1/2-TO-751 F
A1R27	C757-0745	1	RESISTOR-FXD 4.32K 1% .25W F TUBULAR	24546	C5-1/4-T0-4321-F
A1R28	0757-0340	2	RESISTOR-FXD 10K 1% .25 WF	24546	C5-1/4-TO-1002-F
A1R29	C811-3255	4	RESISTOR-FXD 7.5K 3% 4W PW TUBULAR	00213	1300NS
A1R30	C811-3255		RESISTOR-FXD 7.5K 3% 4W PW TUBULAR	00213	1300NS
A1R31	C684-0271		RESISTOR-FXD 2.7 OHM 10% .25W CC	01121	CB27G1
A1R32	C684-0271		RESISTOR-FXD 2.7 OHM 10% .25W CC	01121	CB27G1
A1R33	0757-0367		RESISTOR-FXD 100K 1% .5W F TUBULAR	30983	MF7C1/2-T0-1003-F
A1R34	C687-4701		RESISTOR-FXD 47 OHM 10% .5W CC TUBULAR	01121	EB4701
A1R35	C687-1041		RESISTOR-FXD 100K 10% .5W CC TUBULAR	01121	EB1041
A1R36	0687-1041		RESISTOR-FXD 100K 10% .5W CC TUBULAR	01121	EB1041
A1R37	C757-0833		RESISTOR-FXD 5.11K 1% .5W F TUBULAR	30983	MF7C1/2-T0-5111-F
A1R38	C757-0416		RESISTOR-FXD 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-F
A1R39	C687-3321		RESISTOR-FXD 3.3K 10% .5W CC TUBULAR	01121	cB3321
A1R40	0687-3321		RESISTOR-FXD 3.3K 10% .5W CC TUBULAR	01121	EB3321
A1R41	0684-2211		RESISTOR-FXD 220 OHM 10% .25W CC	01121	CB2211
A1R42	0684-2211		RESISTOR-FXD 220 OHM 10% .25W CC	01121	CB2211
A1R43	0757-0833		RESISTOR-FXD 5.11K 1% .5 WF	30983	MF7C1/2-TO-5111-F
A1R44	0757-0419		RESISTOR-FXD 681 1% .12 WF	24546	C4 1/8-TO-681R-F
A1R45	0684-4731		RESISTOR-FXD 47K 10% .25W CC TUBULAR	01121	CB4731
A1R46	0684-4731		RESISTOR-FXD 47K 10% .25W CC TUBULAR	01121	CB4731
A1R47	C757-0422		RESISTOR-FXD 909 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-909R-F
A1R48	2100-0567		RESISTOR, VAR, TRMR, 2KOHM 10% C	73138	72PR2K
A1R49	C69E-3159		RESISTOR-FXD 26.1K 1% .125W F TUBULAR	16299	C4-1/8-T0-2612-F
A1R50	C69E-3159		RESISTOR-FXD 26.1K 1% .125W F TUBULAR	16299	C4-1/8-T0-2612-F
A1R51	C69E-0085		RESISTOR-FXD 2.61K 1% .125W F TUBULAR	16299	C4-1/8-T0-2611-F
A1R52	C69E-0085		RESISTOR-FXD 2.61K 1% .125W F TUBULAR	16299	C4-1/8-T0-2611-F
A1R53	C757-0749		RESISTOR-FXD 6.19K 1% .25W F TUBULAR	24546	C5-1/4-T0-6191-F
A1R54	C757-0413		RESISTOR-FXD 392 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-392R-F
A1R55	C757-0834		RESISTOR-FXD 5.62K 1% .5W F TUBULAR	30983	MF7C1/2-T0-5621-F
A1R56	0757-0817		RESISTOR FXD 750 1% .5 WF	30983	MF7C1/2 TO-751-F
A1R58	0757-0340		RESISTOR-FXD 10K 1% .25 WF	24546	C5-1/4-TO-1002 F
A1R59	0811-3255		RESISTOR-FXD 7.5K 3% 4W PW TUBULAR	00213	1300NS
A1R60	C811-3255		RESISTOR-FXD 7.5K 3% 4W PW TUBULAR	00213	1300NS
A1R61	0683 7515	1	RESISTOR FXD 750 5% .25 WCC	01121	CB 7515
A1R63	C684-1031	11	RESISTOR-FXD 10K 10% .25W CC TUBULAR	01121	CB1031

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1R67	0757-0453	1	RESISTOR-FXD 30.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-3012-F
A1R68	C684-1011	2	RESISTOR-FXD 100 OHM 10% .25W CC	01121	CB1011
A1R69	C757-0427	1	RESISTOR-FXD 1.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-1501-F
A1R70	C684-2231	10	RESISTOR-FXD 22K 10% .25W CC TUBULAR	01121	CB2231
A1R71	0684-2231		RESISTOR-FXD 22K 10% .25W CC TUBULAR	01121	CB2231
A1R72	C684-2231		RESISTOR-FXD 22K 10% .25W CC TUBULAR	01121	CB2231
A1R73	0684-1031		RESISTOR-FXD 10K 10% .25W CC TUBULAR	01121	CB1031
A1R74	C757-0759	1	RESISTOR-FXD 18.2K 1% .25W F TUBULAR	24546	C5-1/4-T0-1822-F
A1R75	C757-0429	2	RESISTOR-FXD 1.82K 1% .125W F TUBULAR	24546	C4-1/8-T0-1821-F
A1R80	0757-0761	1	RESISTOR-FXD 22.1K 1% .25W F TUBULAR	24546	C5-1/4-T0-2212-F
A1R82	2100-0558	1	RESISTOR, VAR, TRMR, 20KOHM 10% C	73138	72P
A1R84	C757-0430	1	RESISTOR-FXD 2.21K 1% .125W F TUBULAR	24546	C4-1/8-T0-2211-F
A1R87	0757-0768	2	RESISTOR-FXD 47.5K 1% .25W F TUBULAR	24546	C5-1/4-T0-4752-F
A1R88	C757-0768		RESISTOR-FXD 47.5K 1% .25W F TUBULAR	24546	C5-1/4-T0-4752-F
A1R89	C684-1021	5	RESISTOR-FXD 1K 10% .25W CC TUBULAR	01121	CB1021
A1R90	C684-1031		RESISTOR-FXD 10K 10% .25W CC TUBULAR	01121	CB1031
A1R91	0684-5621	1	RESISTOR-FXD 5.6K 10% .25W CC TUBULAR	01121	CB5621
A1R92	0684-1031		RESISTOR-FXD 10K 10% .25W CC TUBULAR	01121	CB1031
A1R94	0684-2721	2	RESISTOR-FXD 2.7K 10% .25W CC TUBULAR	01121	CB2721
A1R95	0684-1031		RESISTOR-FXD 10K 10% .25W CC TUBULAR	01121	CB1031
A1R98	C684-2721		RESISTOR-FXD 2.7K 10% .25W CC TUBULAR	01121	CB2721
A1R99	0684-1031		RESISTOR-FXD 10K 10% .25W CC TUBULAR	01121	CB1031
A1R100	C684-1041	3	RESISTOR-FXD 100K 10% .25W CC TUBULAR	01121	CB1041
A1R101	C684-1031		RESISTOR-FXD 10K 10% .25W CC TUBULAR	01121	CB1031
A1R102	0684-1231	3	RESISTOR-FXD 12K 10% .25W CC TUBULAR	01121	CB1231
A1R103	C757-0281	1	RESISTOR-FXD 2.74K 1% .125W F TUBULAR	24546	C4-1/8-T0-2741-F
A1R104	0757-0283	2	RESISTOR-FXD 2K 1% .125W F TUBULAR	24546	C4-1/8-T0-2001-F
A1R105	0757-0465	3	RESISTOR-FXD 100K 1% .125W F TUBULAR	24546	C4-1/8-T0-1003-F
A1R106	C684-1041		RESISTOR-FXD 100K 10% .25W CC TUBULAR	01121	CB1041
A1R107	0684-1231		RESISTOR-FXD 12K 10% .25W CC TUBULAR	01121	CB1231
A1R108	C684-1221	2	RESISTOR-FXD 1.2K 10% .25W CC TUBULAR	01121	CB1221
A1R109	0757-0429		RESISTOR-FXD 1.82K 1% .125W F TUBULAR	24546	C4-1/8-T0-1821-F
A1R110	0757-0465		RESISTOR-FXD 100K 1% .125W F TUBULAR	24546	C4-1/8-T0-1003-F
A1R111	C757-0447	1	RESISTOR-FXD 16.2K 1% .125W F TUBULAR	24546	C4-1/8-T0-1622-F
A1R112	C684-1531	3	RESISTOR-FXD 15K 10% .25W CC TUBULAR	01121	CB1531
A1R113	C684-4741	2	RESISTOR-FXD 470K 10% .25W CC TUBULAR	01121	CB4741
A1R114	C684-1031		RESISTOR-FXD 10K 10% .25W CC TUBULAR	01121	CB1031
A1R115	0684-4731		RESISTOR-FXD 47K 10% .25W CC TUBULAR	01121	CB4731
A1R116	C698-6410	1	RESISTOR-FXD 6.34M 2% .5W F TUBULAR	07716	SERIES CEC,TR
A1R117	C684-1221		RESISTOR-FXD 1.2K 10% .25W CC TUBULAR	01121	CB1221
A1R118	C684-8231	2	RESISTOR-FXD 82K 10% .25W CC TUBULAR	01121	CB8231
A1R119	C684-2231		RESISTOR-FXD 22K 10% .25W CC TUBULAR	01121	CB2231
A1R120	0684-1031		RESISTOR-FXD 10K 10% .25W CC TUBULAR	01121	CB1031
A1R122	0757-0280	1	RESISTOR-FXD 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A1R123	0684-2211		RESISTOR-FXD 220 OHM 10% .25W CC	01121	CB2211
A1R124	C684-1021		RESISTOR-FXD 1K 10% .25W CC TUBULAR	01121	CB1021
A1R125	0757-0749		RESISTOR-FXD 6.19K 1% .25W F TUBULAR	24546	C5-1/4-T0-6191-F
A1R126	0684-4711	1	RESISTOR-FXD 470 OHM 10% .25W CC	01121	CB4711
A1R127	0757-0340	1	RESISTOR-FXD 10K 1% .25W F TUBULAR	24546	C5-1/4-T0-1002-F
A1R128	0684-2231		RESISTOR-FXD 22K 10% .25W CC TUBULAR	01121	CB2231
A1R129	2100-3253	1	RESISTOR,VAR,TRMR 50K OHM 10% C	32997	3389P-1-503
A1R130	0684-2231		RESISTOR-FXD 22K 10% .25W CC TUBULAR	01121	CB2231
A1R131	C684-1541	2	RESISTOR-FXD 150K 10% .25W CC TUBULAR	01121	CB1541
A1R132	0684-1541		RESISTOR-FXD 150K 10% .25W CC TUBULAR	01121	CB1541
A1R133	0684-1531		RESISTOR-FXD 15K 10% .25W CC TUBULAR	01121	CB1531
A1R134	0684-4731		RESISTOR-FXD 47K 10% .25W CC TUBULAR	01121	CB4731
A1R137	C698-3451	1	RESISTOR-FXD 133K 1% .125W F TUBULAR	16299	C4-1/8-T0-1333-F
A1R138	0684-2231		RESISTOR-FXD 22K 10% .25W CC TUBULAR	01121	CB2231
A1R139	0684-2231		RESISTOR-FXD 22K 10% .25W CC TUBULAR	01121	CB2231
A1R140	C684-2231		RESISTOR-FXD 22K 10% .25W CC TUBULAR	01121	CB2231
A1R141	0684-1231		RESISTOR-FXD 12K 10% .25W CC TUBULAR	01121	CB1231
A1R142	C684-1531		RESISTOR-FXD 15K 10% .25W CC TUBULAR	01121	CB1531
A1R143	0757-0342	1	RESISTOR-FXD 100K 1% .25W F TUBULAR	24546	C5-1/4-T0-1003-F
A1R144	C684-4731		RESISTOR-FXD 47K 10% .25W CC TUBULAR	01121	CB4731
A1R145	2100-3214	1	RESISTOR,VAR,TRMR 100K OHM 10% C	32997	3389P-1-104
A1R146	C684-8231		RESISTOR-FXD 82K 10% .25W CC TUBULAR	01121	CB8231
A1R147	C757-0465		RESISTOR-FXD 100K 1% .125W F TUBULAR	24546	C4-1/8-T0-1003-F
A1R148	C684-2741	1	RESISTOR-FXD 270K 10% .25W CC TUBULAR	01121	CB2741
A1R149	C684-4741		RESISTOR-FXD 470K 10% .25W CC TUBULAR	01121	CB4741
A1R150	0684-4731		RESISTOR-FXD 47K 10% .25W CC TUBULAR	01121	CB4731
A1R151	C757-0445	2	RESISTOR-FXD 13K 1% .125W F TUBULAR	24546	C4-1/8-T0-1302-F
A1R152	0684-1031		RESISTOR-FXD 10K 10% .25W CC TUBULAR	01121	CB1031
A1R153	C811-1671	1	RESISTOR-FXD 2.7 OHM 5% 2W PW TUBULAR	75042	BWH2-2R7-J
A1R154	C684-6821	1	RESISTOR-FXD 6.8K 10% .25W CC TUBULAR	01121	CB6821

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1R155	C684-2231		RESISTOR-FXD 22K 10% .25W CC TUBULAR	01121	CB2231
A1R157	C757-0976	1	RESISTOR-FXD 150K 2% .125W F TUBULAR	24546	C4-1/8-T0-1502-G
A1R159	C757-0200	1	RESISTOR-FXD 5.62K 1% .125W F TUBULAR	24546	C4-1/8-T0-5621-F
A1R160	2100-0567		RESISTOR, VAR, TRMR, 2KOHM 10% C	73138	72PR2K
A1R161	C757-0450	1	RESISTOR-FXD 22.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-2212-F
A1R162	C684-1011		RESISTOR-FXD 100 OHM 10% .25W CC	01121	CB1011
A1R163	C684-4701	1	RESISTOR-FXD 47 OHM 10% .25W CC TUBULAR	01121	CB4701
A1R164	J767-0014	1	RESISTOR-FXD 1.5K 5% 3W MO TUBULAR	24546	FP32-3-250-2002-J
A1R165	C764-0033	1	RESISTOR-FXD 33 OHM 5% 2W MO TUBULAR	24546	FP42-2-T00-3302-J
A1R166	C684-1021		RESISTOR-FXD 1K 10% .25W CC TUBULAR	01121	CB1021
A1R167	C684-2241	1	RESISTOR-FXD 220K 10% .25W CC TUBULAR	01121	CB2241
A1R168	C684-3321	1	RESISTOR-FXD 3.3K 10% .25W CC TUBULAR	01121	CB3321
A1R169	C757-0388	1	RESISTOR-FXD 30.1 OHM 1% .125W F	24546	C4-1/8-T0-30R1-F
A1R170	C757-0458	1	RESISTOR-FXD 51.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-5112-F
A1R171	C684-1041		RESISTOR-FXD 100K 10% .25W CC TUBULAR	01121	CB1041
A1R172	C698-3423	1	RESISTOR-FXD 46.4K 1% .5W F TUBULAR	19701	MF7C1/2-T0-4642-F
A1R173	C757-0851	1	RESISTOR-FXD 43.2K 1% .5W F TUBULAR	30983	MF7C1/2-T0-4322-F
A1R175	C757-0839	1	RESISTOR-FXD 10K 1% .5W F TUBULAR	30983	MF7C1/2-T0-1002-F
A1R176	C684-1031		RESISTOR-FXD 10K 10% .25W CC TUBULAR	01121	CB1031
A1R177			NOT ASSIGNED		
A1R178	C757-0954	1	RESISTOR-FXD 18K 2% .125W F TUBULAR	24546	C4-1/8-T0-1802-G
A1R179	C757-0445		RESISTOR-FXD 13K 1% .125W F TUBULAR	24546	C4-1/8-T0-1302-F
A1R180	C757-0469	1	RESISTOR-FXD 150K 1% .125W F TUBULAR	24546	C4-1/8-T0-1503-F
A1R182	C757-0394	4	RESISTOR-FXD 51.1 OHM 1% .125W F	24546	C4-1/8-T0-51R1-F
A1R183	C757-0394		RESISTOR-FXD 51.1 OHM 1% .125W F	24546	C4-1/8-T0-51R1-F
A1R184	C757-0394		RESISTOR-FXD 51.1 OHM 1% .125W F	24546	C4-1/8-T0-51R1-F
A1R185	C757-0394		RESISTOR-FXD 51.1 OHM 1% .125W F	24546	C4-1/8-T0-51R1-F
A1R186	C684-0271		RESISTOR-FXD 2.7 OHM 10% .25W CC	01121	CB27G1
A1R187	C684-0271		RESISTOR-FXD 2.7 OHM 10% .25W CC	01121	CB27G1
A1R188	C684-0271		RESISTOR-FXD 2.7 OHM 10% .25W CC	01121	CB27G1
A1R189	C684-0271		RESISTOR-FXD 2.7 OHM 10% .25W CC	01121	CB27G1
A1R190	C684-0271		RESISTOR-FXD 2.7 OHM 10% .25W CC	01121	CB27G1
A1R191	C684-4721	1	RESISTOR-FXD 4.7K 10% .25W CC TUBULAR	01121	CB4721
A1R195	0684-1021	1	RESISTOR-FXD 1K 10% .25W CC TUBULAR	01121	CB1121
A1R196	0684-1021	1	RESISTOR-FXD 1K 10% .25W CC TUBULAR	01121	CB1121
A1U1	1826-0119	2	IC;LIN;MISCELLANEOUS (LINEAR)	18324	NE555T
A1U2	1826-0119		IC;LIN;MISCELLANEOUS (LINEAR)	18324	NE555T
A1VR1	1902-3182	2	DIODE; ZENER; 12.1V VZ; .4W MAX PD	04713	SZ 10939-206
A1VR2	1902-3182		DIODE; ZENER; 12.1V VZ; .4W MAX PD	04713	SZ 10939-206
A1VR4	1902-3323	1	DIODE; ZENER; 42.2V VZ; .4W MAX PD	04713	SZ 10939-362
A1VR5	1902-0172	1	DIODE; ZENER; 17.8V VZ; .4W MAX PD	28480	1902-0172
A1VR6	1902-3104	1	DIODE; ZENER; 5.62V VZ; .4W MAX PD	04713	SZ 10939-110
A1VR7	1902-3393	2	DIODE; ZENER; 75V VZ; .4W MAX PD	04713	SZ 10939-434
A1VR8	1902-3393		DIODE; ZENER; 75V VZ; .4W MAX PD	04713	SZ 10939-434
A1XA2	1251-3213	2	CONNECTOR, PC EDGE, 15-CONT, DIP SOLDER	26742	91-6915-1700-00
A1XA4	1251-2091	1	CONNECTOR, PC EDGE, 15-CONT, RTANG DP	26742	178-118-181
A1XA7	1251-1283	1	CONNECTOR, PC EDGE, 6-CONT, DIP SOLDER	26742	91-6906-1700-00
A1XA8	1251-0213		CONNECTOR, PC EDGE, 15-CONT, DIP SOLDER	26742	91-6915-1700-00
A1XF1	2110-0269	2	FUSEHOLDER; CLIP TYPE	28480	2110-0269
A2	01331-66533	1	Z AMPLIFIER/HIGH VOLTAGE BOARD ASSY	28480	01331-66533
A2C1	C140-0192	1	CAPACITOR-FXD 68PF+-5% 300WVDC	72136	DM15E680J0300WV1CR
A2C2	C150-0021	1	CAPACITOR-FXD .47PF+-5% 500WVDC	95121	TYPE QC
A2C3	0121-0168	1	CAPACITOR, VAR, TRMR, PSTN, .2/1.5PF	28480	0121-0168
A2C4	C160-2145	1	CAPACITOR-FXD .005UF+80-20% 100WVDC	28480	0160-2145
A2C5	C160-3453	4	CAPACITOR-FXD .05UF+80-20% 100WVDC	28480	0160-3453
A2C6	0160-3453		CAPACITOR-FXD .05UF +80-20% 100WVDC	28480	0160-3453
A2C7	C160-3453		CAPACITOR-FXD .05UF+80-20% 100WVDC	28480	0160-3453
A2C8	0160-0165	2	CAPACITOR-FXD .056UF+-10% 200WVDC	56289	292P56392
A2C9	C180-0109	1	CAPACITOR-FXD ELECT 18 UF 100VDCW	56289	400186F100DH 6M1
A2C12	C170-0024	1	CAPACITOR-FXD .022UF+-20% 200WVDC	56289	292P22302
A2C13	C160-0165		CAPACITOR-FXD .056UF+-10% 200WVDC	56289	292P56392
A2C14	0160-4079	1	CAPACITOR-FXD .0015UF +-20% 4000WVDC	28480	0160-4079
A2C15	C160-0167	1	CAPACITOR-FXD .082UF+-10% 200WVDC	56289	292P82392
A2C16	C160-0543	5	CAPACITOR-FXD .0047UF+-20% 400CWVDC	84411	HEW-337
A2C17	C160-0543		CAPACITOR-FXD .0047UF+-20% 4000WVDC	84411	HEW-337
A2C18	C160-0543		CAPACITOR-FXD .0047UF+-20% 4000WVDC	84411	HEW-337
A2C19	C160-0543		CAPACITOR-FXD .0047UF+-20% 4000WVDC	84411	HEW-337
A2C20	C160-0543		CAPACITOR-FXD .0047UF+-20% 4000WVDC	84411	HEW-337
A2C21	C180-0091	1	CAPACITOR-FXD; 100UF+50-10% 100VDC AL	56289	30D106F100DC2
A2C22	C160-3453		CAPACITOR-FXD .05UF+80-20% 100WVDC	28480	0160-3453
A2C23	0180-1735	1	CAPACITOR-FXD; .22UF+-10% 35VDC TA	56289	150D224X9035A2
A2C24	C180-0116	1	CAPACITOR-FXD; 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A2CR1	1901-0040	12	DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A2CR2	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A2CR3	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A2CR4	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2CR5	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A2CR6	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A2CR7	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A2CR8	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A2CR9	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A2CR10	1901-0028	1	DIODE; PWR RECT; ; 400V MAX VRM 750MA	04713	SR1358-9
A2CR11	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A2CR12	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A2CR13	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A2CR14	1901-0045	1	DIODE; PWR RECT; ; 50V MAX VRM 750MA	28480	1901-0049
A2L1	9140-0129	2	COIL; FXD; MOLDED RF CHOKE; 220UH 5%	24226	15/223
A2L2	9140-0129		COIL; FXD; MOLDED RF CHOKE; 220UH 5%	24226	15/223
A2L3	9140-0179	1	COIL; FXD; MOLDED RF CHOKE; 22UH 10%	24226	15/222
A2Q1	1854-0215	3	TRANSISTOR NPN SI PD=310MW FT=300MHZ	04713	SPS 3611
A2Q2	1854-0215		TRANSISTOR NPN SI PD=310MW FT=300MHZ	04713	SPS 3611
A2Q3	1854-0215		TRANSISTOR NPN SI PD=310MW FT=300MHZ	04713	SPS 3611
A2Q4	1853-0036	2	TRANSISTOR PNP SI CHIP PD=310MW	28480	1853-0036
A2Q5	1853-0038	1	TRANSISTOR PNP SI CHIP PD=1W	28480	1853-0038
A2Q6	1854-0271	1	TRANSISTOR NPN SI PD=1W FT=150MHZ	28480	1854-0271
A2Q7	1853-0036		TRANSISTOR PNP SI CHIP PD=310MW	28480	1853-0036
A2Q8	1855-0057	1	TRANSISTOR; J-FET N-CHAN, D-MODE SI	28480	1855-0057
A2R1	C757-0401	2	RESISTOR-FXD 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A2R2	C757-0401		RESISTOR-FXD 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A2R3	C757-0442	2	RESISTOR-FXD 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A2R4	C757-0442		RESISTOR-FXD 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A2R5	C757-0755	1	RESISTOR-FXD 12.1K 1% .25W F TUBULAR	24546	C5-1/4-T0-1212-F
A2R6	C757-0410	2	RESISTOR-FXD 301 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-3010-F
A2R7	C757-0410		RESISTOR-FXD 301 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-3010-F
A2R8	C757-0283	2	RESISTOR-FXD 2K 1% .125W F TUBULAR	24546	C4-1/8-T0-2001-F
A2R9	C757-0406	1	RESISTOR-FXD 182 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-182R-F
A2R10	C757-0752	2	RESISTOR-FXD 8.25K 1% .25W F TUBULAR	24546	C5-1/4-T0-8251-F
A2R11	C757-0752		RESISTOR-FXD 8.25K 1% .25W F TUBULAR	24546	C5-1/4-T0-8251-F
A2R12	C757-0283		RESISTOR-FXD 2K 1% .125W F TUBULAR	24546	C4-1/8-T0-2001-F
A2R13	0684-2231	1	RESISTOR-FXD 22K 10% .25W CC TUBULAR	01121	CB2231
A2R14	C757-0124	2	RESISTOR-FXD 39.2K 1% .125W F TUBULAR	24546	C4-1/8-T0-3922-F
A2R15	C698-3158	1	RESISTOR-FXD 23.7K 1% .125W F TUBULAR	16299	C4-1/8-T0-2372-F
A2R16	C757-0458	1	RESISTOR-FXD 51.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-5112-F
A2R17	C698-5102	1	RESISTOR-FXD 1.2M 10% .25W CC TUBULAR	01121	CB1251
A2R18	C757-0199	2	RESISTOR-FXD 21.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-2152-F
A2R19	C757-0199		RESISTOR-FXD 21.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-2152-F
A2R20	C698-3136	1	RESISTOR-FXD 17.8K 1% .125W F TUBULAR	16299	C4-1/8-T0-1782-F
A2R21	C757-0449	1	RESISTOR-FXD 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A2R22	C757-0760	1	RESISTOR-FXD 20K 1% .25W F TUBULAR	24546	C5-1/4-T0-2002-F
A2R23	C757-0757	1	RESISTOR-FXD 15K 1% .25W F TUBULAR	24546	C5-1/4-T0-1502-F
A2R24	C757-0280	1	RESISTOR-FXD 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A2R25	C757-0408	1	RESISTOR-FXD 243 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-243F-F
A2R28	0684-2211	1	RESISTOR-FXD 220 OHM 10% .25W CC	01121	CB2211
A2R29	0684-1511	1	RESISTOR-FXD 150 OHM 10% .25W CC	01121	CB1511
A2R30	C757-0438	1	RESISTOR-FXD 5.11K 1% .125W F TUBULAR	24546	C4-1/8-T0-5111-F
A2R31	C757-0465	1	RESISTOR-FXD 100K 1% .125W F TUBULAR	24546	C4-1/8-T0-1003-F
A2R32	0684-1241	1	RESISTOR-FXD 120K 10% .25W CC TUBULAR	01121	CB1241
A2R33	2100-3355	1	RESISTOR, VAR, TRMR, 100KOHM 10% C	73138	72XR104
A2R34	C757-0135	1	RESISTOR-FXD 511K 1% .5W F TUBULAR	30983	MF7C1/2-T0-5113-F
A2R35	C698-7182	1	RESISTOR-FXD 30M 1% 2W F TUBULAR	03888	PME80-2-T0-3005-F
A2R36	C836-0003	1	RESISTOR-FXD 29M 10% 1W CF TUBULAR	77764	88FW
A2R37	0684-1051	1	RESISTOR-FXD 1M 10% .25W CC TUBULAR	01121	CB1051
A2R38	2100-3257	1	RESISTOR, VAR, TRMR, 20KOHM 10% C	73138	72XWR203
A2R39	C687-1211	1	RESISTOR-FXD 120 OHM 10% .5W CC TUBULAR	01121	EB1211
A2R40	0687-2751	1	RESISTOR-FXD 2.7M 10% .5W CC TUBULAR	01121	EB2751
A2R41	C693-6851	4	RESISTOR-FXD 6.8M 10% 2W CC TUBULAR	01121	HB6851
A2R42	C693-6851		RESISTOR-FXD 6.8M 10% 2W CC TUBULAR	01121	HB6851
A2R43	C693-6851		RESISTOR-FXD 6.8M 10% 2W CC TUBULAR	01121	HB6851
A2R44	C693-6851		RESISTOR-FXD 6.8M 10% 2W CC TUBULAR	01121	HB6851
A2R45	0698-3417	1	RESISTOR-FXD 23.7K 1% .5W F TUBULAR	19701	MF7C1/2-T0-2372-F
A2R46	C698-4935	1	RESISTOR-FXD 41.2K 1% .5W F TUBULAR	03888	PME65-1/2-T0-4122-F
A2R47	C687-1001	1	RESISTOR-FXD 10 OHM 10% .5W CC TUBULAR	01121	EB1001
A2R48	C698-3338	1	RESISTOR-FXD 1.5K 5% 2W MO TUBULAR	16299	FP42-2-1501-J
A2R49	0684-4701	1	RESISTOR-FXD 47 OHM 10% .25W CC TUBULAR	01121	CB4701
A2R50	C757-0124		RESISTOR-FXD 39.2K 1% .125W F TUBULAR	24546	C5-1/4-T0-3922-F
A2V1	2140-0013	2	LAMP, GLOW, BULB T-2, 57V	74276	NE23A
A2V2	2140-0013		LAMP, GLOW, BULB T-2, 57V	74276	NE23A
A2VR1	1902-3182	1	DIODE; ZENER; 12.1V VZ; .4W MAX PD	04713	SZ 10939-206
A3	01331-61903	1	PUSHBUTTON ASSY	28480	01331-61903
A3C1	0160-3443	1	CAPACITOR-FXD .1UF+80-20% 50WVDC	28480	0160-3443
A3S1	3101-0875	1	SWITCH, PUSHBUTTON 3-STATION	28480	3101-0875
A4	01331-66534	1	PROGRAM BOARD ASSY	28480	01331-66534

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4C1	0140-0194	1	CAPACITOR-FXD 110PF+-5% 300WVDC	72136	DM15F111J0300WV1CR
A4C2	0180-0197	1	CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A4C3	0160-2210	1	CAPACITOR-FXD 470PF+-5% 300WVDC	28480	0160-2210
A4C4	0140-0206	1	CAPACITOR-FXD 270PF+-5% 500WVDC	72136	DM15F271J0500WV1CR
A4C5	0180-1746	1	CAPACITOR-FXD; 15UF+-10% 20VDC TA-SOLID	56289	150D156X9020B2
A4CR1	1901-0040	3	DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A4CR2	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A4CR3	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A4Q1	1854-0071	5	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q2	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q3	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q4	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q5	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q7	1854-0358	1	TRANSISTOR NPN SI PD=310MW FT=60MHZ	28480	1854-0358
A4R1	0698-3156	2	RESISTOR-FXD 14.7K 1% .125W F TUBULAR	16299	C4-1/8-T0-1472-F
A4R2	0698-0084	2	RESISTOR-FXD 2.15K 1% .125W F TUBULAR	16299	C4-1/8-T0-2151-F
A4R3	0698-3451	2	RESISTOR-FXD 133K 1% .125W F TUBULAR	16299	C4-1/8-T0-1333-F
A4R4	0684-1031	5	RESISTOR-FXD 10K 10% .25W CC TUBULAR	01121	CB1031
A4R5	0684-1041	1	RESISTOR-FXD 100K 10% .25W CC TUBULAR	01121	CB1041
A4R6	0757-0442	1	RESISTOR-FXD 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A4R7	0757-0440	1	RESISTOR-FXD 7.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-7501-F
A4R8	0684-1031		RESISTOR-FXD 10K 10% .25W CC TUBULAR	01121	CB1031
A4R9	0757-0469	1	RESISTOR-FXD 150K 1% .125W F TUBULAR	24546	C4-1/8-T0-1503-F
A4R10	0684-5621	1	RESISTOR-FXD 5.6K 10% .25W CC TUBULAR	01121	CB5621
A4R11	0698-3156		RESISTOR-FXD 14.7K 1% .125W F TUBULAR	16299	C4-1/8-T0-1472-F
A4R12	0684-2211	1	RESISTOR-FXD 220 OHM 10% .25W CC	01121	CB2211
A4R13	0698-0084		RESISTOR-FXD 2.15K 1% .125W F TUBULAR	16299	C4-1/8-T0-2151-F
A4R14	0698-3451		RESISTOR-FXD 133K 1% .125W F TUBULAR	16299	C4-1/8-T0-1333-F
A4R15	0684-1031		RESISTOR-FXD 10K 10% .25W CC TUBULAR	01121	CB1031
A4R16	0684-1031		RESISTOR-FXD 10K 10% .25W CC TUBULAR	01121	CB1031
A4R17	0684-2221	1	RESISTOR-FXD 2.2K 10% .25W CC TUBULAR	01121	CB2221
A4R24	0684-1031		RESISTOR-FXD 10K 10% .25W CC TUBULAR	01121	CB1031
A4R26	2100-3253	1	RESISTOR,VAR,TRMR 50K OHM 10% C	32997	3389P-1-503
A4R27	0757-0453	1	RESISTOR-FXD 30.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-3012-F
A4R34	0684-2201	1	RESISTOR-FXD 22 OHM 10% .25W CC TUBULAR	01121	CB2201
A5	01201-66510	1	HIGH VOLTAGE RECTIFIER ASSY	28480	01201-66510
A5C1	0160-3007	3	CAPACITOR-FXD .0047UF+-20% 4000WVDC	28480	0160-3007
A5C2	0160-3007		CAPACITOR-FXD .0047UF+-20% 4000WVDC	28480	0160-3007
A5C3	C16C-3007		CAPACITOR-FXD .0047UF+-20% 4000WVDC	28480	0160-3007
A5C4	C16C-3008	3	CAPACITOR-FXD .0047UF+-20% 4000WVDC	28480	0160-3008
A5C5	0160-3008		CAPACITOR-FXD .0047UF+-20% 4000WVDC	28480	0160-3008
A5C6	C16C-3008		CAPACITOR-FXD .0047UF+-20% 4000WVDC	28480	0160-3008
A5CR1	1901-0341	2	DIODE:SI 7000 PIV 50MA	28480	1901-0341
A5CR2	1901-0341		DIODE:SI 7000 PIV 50MA	28480	1901-0341
A5MP1	5040-0402	1	MOUNT:TRANSFORMER	28480	5040-0402
A5MP2	5040-0430	1	MOUNT:TRANSFORMER	28480	5040-0430
A5R1	0684-2231	1	RESISTOR-FXD 22K 10% .25W CC TUBULAR	01121	CB2231
A5R2	0684-1531		RESISTOR-FXD 15K 10% .25W CC TUBULAR	01121	CB1531
A5T1	01201-61102	1	TRANSFORMER ASSY:HIGH VOLTAGE	28480	01201-61102
A6	01331-61104	1	N.S.R. HIGH VOLTAGE TRIPLER ASSY	28480	01331-61104
A7	01331-66504	1	LOW VOLTAGE RECTIFIER ASSY	28480	01331-66504
A7C1	0180-2138	1	C:FXD ELECT 150 UF +50-10% 250VDCW	28480	0180-2138
A7C2	0180-2159	2	C:FXD ELECT 300 UF +75-10% 150VDCW	28480	0180-2159
A7C3	0180-2159		C:FXD ELECT 300 UF +75-10% 150VDCW	28480	0180-2159
A7R1	0684-1841	1	RESISTOR-FXD 180K 10% .25W CC TUBULAR	01121	CB1841
A7R2	C684-1041	2	RESISTOR-FXD 100K 10% .25W CC TUBULAR	01121	CB1041
A7R3	0684-1041		RESISTOR-FXD 100K 10% .25W CC TUBULAR	01121	CB1041
A7VCR1	1906-0006	3	DIODE, MULT, FULL WAVE BRIDGE RECTIFIER	28480	1906-0006
A7VCR2	1906-0006		DIODE, MULT, FULL WAVE BRIDGE RECTIFIER	28480	1906-0006
A7VCR3	1906-0006		DIODE, MULT, FULL WAVE BRIDGE RECTIFIER	28480	1906-0006
A8	01331-66502	1	LOW VOLTAGE POWER SUPPLY ASSY	28480	01331-66502
A8C1	C160-0168	2	CAPACITOR-FXD .1UF+-10% 200WVDC	56289	292P10492
A8C2	0180-2134	2	CAPACITOR-FXD; 20UF+50-10% 100VDC AL	56289	34D206F100EJ4
A8C3	C16C-0168		CAPACITOR-FXD .1UF+-10% 200WVDC	56289	292P10492
A8C4	C18C-0157	1	CAPACITOR-FXD; 2.2UF+-10% 20VDC TA	56289	1500225X9020A2
A8C5	C18C-1731	1	CAPACITOR-FXD; 4.7UF+-10% 50VDC TA	56289	150D475X9050B2
A8C6	C18C-2134		CAPACITOR-FXD; 20UF+50-10% 100VDC AL	56289	34D206F100EJ4
A8CR1	1901-0040	6	DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A8CR2	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A8CR3	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A8CR4	1901-0026	2	DIODE; PWR RECT; ; 200V MAX VRM 750MA	04713	SR1358-8
A8CR5	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A8CR6	1901-0040		DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A8CR7	1901-0040	3	DIODE; SWITCHING; ; 30V MAX VRM 50MA	28480	1901-0040
A8CR8	1901-0026	1	DIODE; PWR RECT; ; 200V MAX VRM 750MA	04713	SR1358-8

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A8F1	2110-0004	1	FUSE; .25A 250V	71400	AGC-1/4
A8F2	2110-0012	2	FUSE; .5A 250V	71400	AGC 1/2
A8F3	2110-0012		FUSE; .5A 250V	71400	AGC 1/2
A8Q1	1854-0071	3	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A8Q2	1853-0036	1	TRANSISTOR PNP SI CHIP PD=310MW	28480	1853-0036
A8Q3	1854-0022	1	TRANSISTOR NPN SI PD=700MW FT=50MHZ	07263	S17843
A8Q4	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A8Q5	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A8R1	C698-3605	2	RESISTOR-FXD 15 OHM 5% 2W MO TUBULAR	16299	FP42-2-T00-15R0-J
A8R2	C684-1021	2	RESISTOR-FXD 1K 10% .25W CC TUBULAR	01121	CB1021
A8R3	0757-0456	1	RESISTOR-FXD 43.2K 1% .125W F TUBULAR	24546	C4-1/8-T0-4322-F
A8R4	C764-0043	1	RESISTOR-FXD 2.7K 5% 2W MO TUBULAR	24546	FP42-2-T00-2701-J
A8R5	0757-0392	1	RESISTOR-FXD 43.2 OHM 1% .125W F	24546	C4-1/8-T0-43R2-F
A8R6	C757-0450	1	RESISTOR-FXD 22.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-2212-F
A8R7	C757-0401	1	RESISTOR-FXD 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A8R8	C757-0110	1	RESISTOR-FXD 12.8K 1% .25W F TUBULAR	30983	MF52C1/4-T0-1282-F
A8R9	C698-7142	1	RESISTOR-FXD 12.3K 1% .25W F TUBULAR	24546	C5-1/4-T0-1232-F
A8R10	0684-3321	1	RESISTOR-FXD 3.3K 10% .25W CC TUBULAR	01121	CB3321
A8R11	C698-3605		RESISTOR-FXD 15 OHM 5% 2W MO TUBULAR	16299	FP42-2-T00-15R0-J
A8R12	0684-1021		RESISTOR-FXD 1K 10% .25W CC TUBULAR	01121	CB1021
A8R13	0684-5631	1	RESISTOR-FXD 56K 10% .25W CC TUBULAR	01121	CB5631
A8R14	C698-3443	1	RESISTOR-FXD 287 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-287R-F
A8R15	C757-0750	1	RESISTOR-FXD 6.81K 1% .25W F TUBULAR	24546	C5-1/4-T0-6811-F
A8R16	C684-3331	1	RESISTOR-FXD 33K 10% .25W CC TUBULAR	01121	CB3331
A8R17	C684-4741	2	RESISTOR-FXD 470K 10% .25W CC TUBULAR	01121	CB4741
A8R18	0757-0757	1	RESISTOR-FXD 15K 1% .25W F TUBULAR	24546	C5-1/4-T0-1502-F
A8R19	0684-4741		RESISTOR-FXD 470K 10% .25W CC TUBULAR	01121	CB4741
A8R20	0757-0389	1	RESISTOR-FXD 33.2 OHM 1% .125W F	24546	C4-1/8-T0-33R2-F
A8R21	0757-0433	1	RESISTOR-FXD 3.32K 1% .125W F TUBULAR	24546	C4-1/8-T0-3321-F
A8R22	2100-2982	1	RESISTOR, VAR, TRMR, 1KOHM 20% CC	28480	2100-2982
A8R23	C698-3264	1	RESISTOR-FXD 11.8K 1% .125W F TUBULAR	16299	C4-1/8-T0-1182-F
A8VR1	1902-3357	2	DIODE; ZENER; 56.2V VZ; .4W MAX PD	04713	SZ 10939-398
A8VR2	1902-0034	1	DIODE; ZENER; 5.76V VZ; .4W MAX PD	04713	SZ 10939-112
A8VR3	1902-3357		DIODE; ZENER; 56.2V VZ; .4W MAX PD	04713	SZ 10939-398
A8VR4	1902-0018	1	DICDE; ZENER; 11.7V VZ; .5W MAX PD	04713	1N941
A8FX1	2110-0269	3	FUSEHOLDER; CLIP TYPE	28480	2110-0269
A8FX2	2110-0269		FUSEHOLDER; CLIP TYPE	28480	2110-0269
A8FX3	2110-0269		FUSEHOLDER; CLIP TYPE	28480	2110-0269

Table 6-3. List of Manufacturers' Codes

MFR NO	MANUFACTURER NAME	ADDRESS	ZIP CODE
	NO M/F DESCRIPTION FOR THIS MFG NUMBER		
00213	SAGE ELECTRONICS CORP	ROCHESTER NY	14611
00866	GME ENGINEERING CO INC	CITY OF INDUSTRY CA	91745
01121	ALLEN BRADLEY CO	MILWAUKEE WI	53212
02735	RCA CORP SOLID STATE DIV	SOMMERVILLE NJ	08876
03888	PYROFILM CORP	WHIPPANY NJ	07981
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX AZ	85008
06540	AMATOM ELECTRONIC HARDWARE DIV. MITE CORP	NEW HAVEN CT	06515
07263	FAIRCHILD SEMICONDUCTOR DIV	MOUNTAIN VIEW CA	94040
07716	TRW INC BURLINGTON DIV	BURLINGTON IA	52601
12697	CLAROSTAT MFG CO INC	DOVER NH	03820
16299	CORNING GL WK ELEC CMPNT DIV	RALEIGH NC	27604
18324	SIGNETICS CORP	SUNNYVALE CA	94086
19701	MEPCO/ELECTRA CORP (ME RES)	MINERAL WELLS TX	76067
24226	GOWANDA ELECTRONICS CORP	GOWANDA NY	14070
24546	CORNING GLASS WORKS (C STYLE RES)	BRADFORD PA	16701
26742	METHODE ELECTRONICS INC	CHICAGO IL	60656
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO CA	94304
30983	MEPCO/ELECTRA CORP (MF RES)	SAN DIEGO CA	92121
32997	BOURNS INC TRIMPOT PROD DIV	RIVERSIDE CA	92507
34344	MOTOROLA INC	FRANKLIN PARK ILL	60131
50439	NO M/F DESCRIPTION FOR THIS MFG NUMBER		
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS MA	01247
70903	BELDEN CORP	CHICAGO IL	60644
71400	BUSSMAN MFG DIV OF MCGRAW-EDISON CO	ST LOUIS MO	63017
71450	CTS CORP	ELKHART IN	46514
71590	CENTRALAB ELEK DIV GLOBE-UNION INC	MILWAUKEE WI	53201
71744	CHICAGO MINIATURE LAMP WORKS	CHICAGO IL	60640
72136	ELECTRO MOTIVE MFG CO INC	WILLIMANTIC CT	06226
72982	ERIE TECHNOLOGICAL PRODUCTS INC	ERIE PA	16512
73138	BECKMAN INSTRUMENTS INC HELIPOT DIV	FULLERTON CA	92634
74276	SIGNALITE INC	NEPTUNE NJ	07753
75042	TRW INC PHILADELPHIA DIV	PHILADELPHIA PA	19108
75915	LITTELFUSE INC	DES PLAINES IL	60016
77764	RESISTANCE PRODUCTS CO	HARRISBURG PA	17104
83330	SMITH HERMAN H INC	BROOKLYN NY	11207
84411	TRW CAPACITOR DIV	OGALLALA NE	69153
90949	AMPHENOL SALES DIV OF BUNKER-RAMO	HAZELWOOD MO	63042
91500	ASHEVILLE-SCHOONMAKER MICA CO.	NEWPORT NEWS VA	23607
95121	QUALITY COMPONENTS INC	ST MARYS PA	15857

See introduction to this section for ordering information

SECTION VII

MANUAL CHANGES AND OPTIONS

7-1. INTRODUCTION.

7-2. This section contains information required to backdate or update this manual for a specific instrument. Description of special options and standard options are also in this section.

7-3. MANUAL CHANGES.

7-4. This manual applies directly to the instrument having the same serial prefix shown on the manual title page. If the serial prefix of the instrument is not the same as the one on the title page, find your serial prefix in table 7-1 and make the changes to the manual that are listed for that serial prefix. When making changes listed in table 7-1, make the highest numbered change first. For example, if backdating changes 1, 2, and 3 are required for your serial prefix, do change 3 first, then change 2, and finally change 1. If the serial prefix of the instrument is not listed either on the title page or in table 7-1, refer to the enclosed MANUAL CHANGES sheet for updating information. Also, if a MANUAL CHANGES sheet is supplied, make all indicated ERRATA corrections.

Table 7-1. Manual Changes

Serial Prefix	Make Changes
Prior To: 1319A	Order Manual (Part No. HP 01331-90903) from: Hewlett-Packard Customer Service Center 3333 Logue Avenue Mountain View, CA 94040

7-5. SPECIAL OPTIONS.

7-6. Most customer special application requirements and/or specifications can be met by factory modification of a standard instrument. A standard instrument modified in this way will carry a special option number, such as Model 0000A/Option C01.

7-7. An operating and service manual and a manual insert are provided with each special option instrument. The operating and service manual contains information about the standard instrument. The manual insert for the special option describes the factory modifications required to produce the special option instrument. Amend the operating and service manual by changing it to include all manual insert information (and MANUAL CHANGE sheet information, if applicable). When these changes are made, the operating and service manual will apply to the special option instrument.

7-8. If you have ordered a special option instrument and the manual insert is missing, notify the nearest Hewlett-Packard Sales/Service Office. Be sure to give a full description of the instrument, including the complete serial number and special option number.

7-9. STANDARD OPTIONS.

7-10. Standard options are modifications installed on HP instruments at the factory and are available on request. Contact the nearest Hewlett-Packard Sales/Service Office for information concerning standard options.

7-11. Option X95. Option X95 provides a standard Model 1331A whose external covers match the color scheme of Hewlett-Packard instruments manufactured prior to the adoption of the current HP color scheme. To adapt this manual for use with Option X95 instruments, amend table 6-2 as follows:

MP6: Change HP Part No. and Mfr. Part No. to 01331-04102.
MP7: Change HP Part No. and Mfr. Part No. to 01331-04101.
MP8: Change HP Part No. and Mfr. Part No. to 01331-04103.

7-12. Option 002. Option 002 provides a 2-usec writing speed. To adapt this manual for use with Option 002 instruments, amend table 6-2 as follows:

V1: Change HP Part No and Mfr. Part No. to 5083-2594.

7-13. Option 631. Option 631 provides a standard Model 1331A substituting a CRT without the internal graticule. To adapt this manual for use with Option 631 instruments, amend table 6-2 as follows:

V1: Change HP Part No. and Mfr. Part No. to 5083-2592.

SECTION VIII

SCHEMATICS AND TROUBLESHOOTING

8-1. INTRODUCTION.

8-2. This section contains maintenance and troubleshooting information for Model 1331A. Schematics, block diagrams, component identification illustrations, and waveforms are provided as visual aids to the solution of maintenance problems. Preventive maintenance procedures, repair and replacement information, and troubleshooting procedures are also provided.

8-3. SCHEMATICS.

8-4. LAYOUT AND CONVENTIONS. Schematics are printed on foldout pages for easy reference to the text and illustrations in other sections. The schematics are drawn to show the electronic functions of the circuits. Any one schematic may include all or parts of several different physical assemblies. Non-MIL-standard symbols and conventions used in the schematics are illustrated and defined in table 8-1.

8-5. The schematics are numbered in sequence with a bold number at the lower right-hand corner of each page. These numbers are used to cross reference signal connections between the schematics. At each circuit breaking point, a number in a circle is shown, followed by another number in bold type. The circled number indicates the signal or circuit and the bold number indicates the associated schematic containing the source or destination of the signal. To find the source or destination of the signal, turn to the indicated schematic and find the circled number in question.

8-6. A table on each schematic lists all components shown on the schematic by reference designation. Component reference designators that have been deleted from the schematic are listed below the table.

8-7. All components on printed circuit boards are enclosed by a broken line (illustration 1 on table 8-1). Components on assemblies, that may or may not include printed circuit boards, are enclosed by a dashed line (illustration 2 on table 8-1). Components not physically located on printed circuit boards or assemblies are shown in unenclosed areas of the schematic.

8-8. REFERENCE DESIGNATIONS. The unit system of reference designations used in this manual is in accordance with USA Standard Y32.16-1968, Reference Designations for Electrical and Electronic Parts and Equipment, dated March , 1968.

8-9. Each component is assigned a class letter and a number. This letter-number combination is the basic reference designation. Components which are part of an assembly have, in addition to the basic designation, a prefix designation indicating the assembly of which the component is a part. For instance, resistor R23 on assembly A1 is called A1R23.

8-10. Assemblies are numbered consecutively. If an assembly reference designation is assigned and later deleted, that number is not reused.

8-11. COMPONENT LOCATIONS. Component locations are illustrated adjacent to the schematics. Because the schematics are drawn to show function, portions of a particular assembly may appear on several different schematics. The component locator is printed next to the schematic showing most of the circuitry on the assembly. A particular component locator may appear adjacent to more than one schematic.

8-12. The locations of all adjustment components are shown in Section V.

8-13. PREVENTIVE MAINTENANCE.

8-14. Preventive maintenance consists of periodic inspection, lubrication, cleaning, performance checks, calibration and other services designed to prevent instrument failure. Performance checks and calibration are covered in Section V. Other preventive maintenance services are covered in the following paragraphs.

8-15. MECHANICAL INSPECTION. Periodically inspect the instrument for damaged electrical and mechanical components. Look for excess grease, dirt, and corrosion. Check for loose and misaligned assemblies. Ensure that all screws, fasteners, and covers are tight and serviceable. Refer to the repair and replacement paragraphs in this section for instructions on replacing defective components.

8-16. CLEANING. Painted, glass, and plastic surfaces can be cleaned with a spray-type window cleaner or with a mild soap and water solution. Excess grease can be removed with a degreaser such as M-180 FREON TF DEGREASER manufactured by the Miller-Stevenson Company.

CAUTION

Plastic CRT filters are easily scratched and should not be rubbed with cleaning tissues containing glass fibers or with other abrasive materials or substances.

8-17. Corroded spots should be removed with soap and water. Stubborn residues can be removed with a fine abrasive. When using abrasives, use care to assure that abrasive particles do not fall into the instrument. Areas cleaned with abrasives should be protected from further corrosion by an application of a silicone resin such as GE DRIFILM 88.

8-18. REPAIR AND REPLACEMENT.

8-19. Procedures for replacing and servicing assemblies, subassemblies and components are provided in the following paragraphs. A detailed parts list and ordering information are contained in Section VI.

8-20. PRINTED CIRCUIT BOARDS. The instrument is designed to permit quick repair by replacing printed circuit boards. The defective board can then be repaired or returned to the nearest Hewlett-Packard Sales/Service Office for repair or exchange.

8-21. To remove printed circuit boards, proceed as follows:

a. Disconnect instrument from all signal, control, and power sources.

WARNING

Potentially dangerous voltages may exist even though the instrument is disconnected from the power source. Discharge all outputs of the high voltage power supply by jumpering to ground.

b. Remove top, bottom, or side covers as required.

c. Carefully remove all wires to single-pin connectors on board. If wire color codes are not adequately identified, tag wire to prevent miswiring when board is reinstalled.

d. Remove screw(s) securing board.

e. If board is installed in socket on main board, gently rock board along axis of socket while exerting gentle outward pressure to remove board.

f. To reinstall board, reverse above procedure. If confusion exists on reinstalling wires to single-pin connectors, refer to component locators adjacent to schematics.

8-22. Single-pin connectors are identified on circuit boards (and on component locators) by the color code of the connecting wire. Connector pins on multiple-pin connectors are identified by either a numeral or a letter. The letters G, I, O, and Q have been omitted.

8-23. The printed circuit boards have plated-through component holes. This allows components to be removed by unsoldering from either side of the boards. When removing large components, such as potentiometers, rotate the soldering iron tip from lead to lead while applying pressure (not too much) to the part to lift it from the board. HP Service Note M-20E contains additional information on repair of printed circuit boards.

8-24. Figure 8-5 is included to help identify the leads on common shapes and sizes of semiconductor devices. When removing a semiconductor, use long-nosed pliers as a heat sink between the device and the soldering iron. When replacing a semiconductor, ensure sufficient lead length to dissipate the soldering heat by using the same length of exposed lead as used on the original part.

8-25. CATHODE-RAY TUBE. To remove the CRT. proceed as follows:

WARNING

Wear a face mask or goggles. Wear protective gloves and handle carefully.

a. Disconnect instrument from all signal, control, and power sources.

b. Remove top, bottom, and side covers.

c. Refer to the exploded view in Section VI to identify mechanical parts.

d. Remove wires from neck-pin connectors.

WARNING

Both the CRT post accelerator and the high voltage tripler can retain a potentially dangerous charge. Discharge both to chassis before handling.

e. Disengage connector on CRT Post-accelerator lead (9) between assembly A6 and CRT.

f. Remove CRT cover MP17 (on rear panel).

g. Loosen clamping screw on CRT support MP18.

CAUTION

Attempting to remove the CRT socket at an angle can break the CRT base and keyway.

h. Gently pry CRT socket from CRT base.

i. Remove screen assembly MP31 by pulling upward.

j. Remove 4 screws to remove bezel MP14 and CRT filter MP33.

k. Exerting pressure from base, move CRT forward approximately 1/2 inch.

l. Disconnect collimator lead from button on CRT bell (through hole in side of CRT shield).

m. Push CRT forward until faceplate is clear of front panel.

n. Grasp edges of faceplate and pull forward until entire CRT is clear of front panel.

8-26. To reinstall the CRT, proceed as follows:

a. Place instrument bottom up.

b. With neck pins up, insert CRT until button on bell can be seen through hole in side of CRT shield.

c. Connect collimator lead to button.

d. Push CRT to rear (about 1/2 inch) until neck pins are centered in hole near rear of CRT shield.

e. Reinstall wires to neck pins.

f. Push CRT back until firm resistance is met.

g. Reinstall CRT filter MP33 and bezel MP14.

h. Push CRT socket firmly onto CRT base.

i. Tighten clamping screw on CRT support MP18.

j. Check to insure that graticule is square with bezel.

k. Reinstall CRT cover MP17.

l. Reinstall instrument covers.

8-27. SWITCHES. The pushbutton and slide switches used in the instrument have been designed for long, trouble-free service. Should one of these switches become defective, replacement rather than repair is recommended.

8-28. HEAT SINKS. With one exception, the semiconductor heat sinks used are of the friction type that can be removed by gently pulling them off. When reinstalling, support the bottom of the transistor before pushing the heat sink on to prevent transistor damage due to lead bending.

8-29. Heat sink MP1 on Z-amplifier/high voltage power supply board A2 is installed on two transistors. One of the transistors must be removed to remove or reinstall the heat sink.

8-30. TROUBLESHOOTING.

8-31. The most important prerequisite for successful troubleshooting is understanding how the instrument is designed to operate and correct use of operating controls. Improper control setting or improper interfacing can cause apparent malfunctions. Read Section III (operation and interfacing) for a general explanation of operating considerations. Read Section IV (principles of operation) for explanations of circuit theory.

8-32. If trouble is suspected, visually inspect the instrument. Look for loose or burned components that might suggest a source of trouble. Check to see that all circuit connections are making good contact and are not shorting to adjacent circuits. If no obvious trouble is found, check power supply voltages. Prior to extensive troubleshooting, also check the external power source.

8-33. DC VOLTAGES. On some of the schematics, dc voltages are indicated for active components. Conditions for making these voltage measurements are listed adjacent to the schematics. Because the conditions for making the measurements may differ from one circuit to another, always check the specific condition shown adjacent to the schematic.

8-34. WAVEFORMS. Waveform measurement points are placed on the schematics along main signal paths. The numbers inside the measurement point symbols are keyed to waveforms and waveform measurement conditions adjacent to the schematics. Like the dc voltage measurement conditions, waveform measurement conditions vary from one circuit to another.

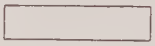
8-35. TROUBLE ISOLATION. The power supplies and amplifiers are conventional and respond to conventional troubleshooting techniques. The overall block diagram, figure 8-1 and schematics 1 through 5 are provided as troubleshooting guides.

8-36. The pulse circuits (schematic 3) react differently for three different modes and functions. Schematic 3 is reproduced in figures 8-2 through 8-4 as a block diagram with signal paths, dc voltages, and waveforms for each of the three conditions. These special troubleshooting block diagrams can be used along with the overall block diagram to isolate any problem to a particular stage. Once this stage is reached, progressive troubleshooting techniques (waveform analysis, voltage measurement, resistance measurement, and substitution) are employed between the input and output of the stage to isolate the malfunction to a particular component(s).

Table 8-1. Schematic Notes

Refer to MIL-STD-15-1A and MIL-STD-806 for schematic symbols not listed in this table.

ETCHED CIRCUIT BOARD


FRONT-PANEL MARKING

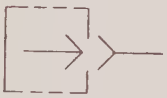
REAR-PANEL MARKING

FRONT-PANEL CONTROL

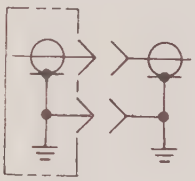
SCREWDRIVER ADJUSTMENT

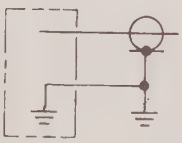
ELECTRICAL TEST POINT
TP (WITH NUMBER)

WAVEFORM TEST POINT
(WITH NUMBER)


SINGLE-PIN CONNECTOR ON BOARD

PIN OF A PLUG-IN BOARD
(WITH LETTER OR NUMBER)


COAXIAL CABLE CONNECTED TO SNAP-ON JACK


COAXIAL CABLE CONNECTED DIRECTLY TO BOARD

MAIN SIGNAL PATH

PRIMARY FEEDBACK PATH

SECONDARY FEEDBACK PATH

P/O — PART OF

NC — NO CONNECTION

CW — CLOCKWISE END OF VARIABLE RESISTOR

FIELD-EFFECT TRANSISTOR
(P-TYPE BASE)

FIELD-EFFECT TRANSISTOR
(N-TYPE BASE)

BREAKDOWN DIODE
(VOLTAGE REGULATOR)

TUNNEL DIODE

STEP-RECOVERY DIODE

CIRCUITS OR COMPONENTS DRAWN WITH DASHED LINES (PHANTOM) SHOW FUNCTION ONLY.

6 SIGNAL REFERENCE

2 SCHEMATIC REFERENCE

(925) WIRE COLORS ARE GIVEN BY NUMBERS IN PARENTHESIS USING THE RESISTOR COLOR CODE

[(925) IS WHT-RED-GRN]

0 - BLACK
1 - BROWN
2 - RED
3 - ORANGE
4 - YELLOW
5 - GREEN
6 - BLUE
7 - VIOLET
8 - GRAY
9 - WHITE

VF (A) V, Voltage
F, Filtered
(A), Filter Source

UNLESS OTHERWISE INDICATED:
RESISTANCE IN OHMS
CAPACITANCE IN PICOFARADS
INDUCTANCE IN MICROHENRIES

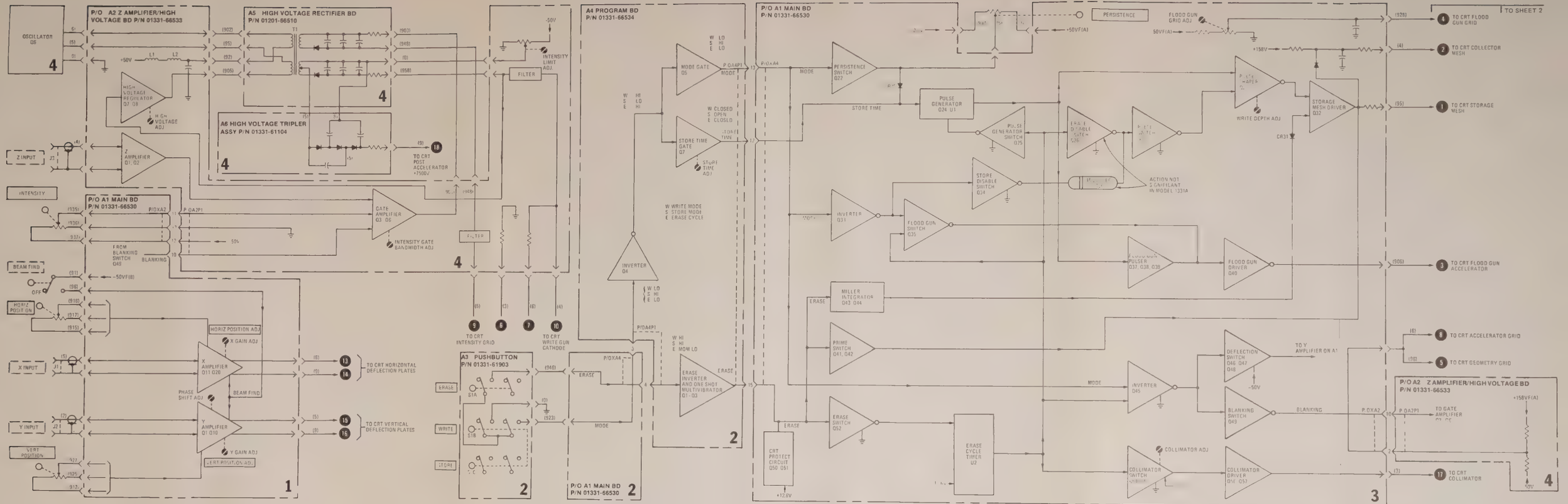


Figure 8-1. Main Block Diagram, Model 1331A (Sheet 1 of 2)

Model 1331A

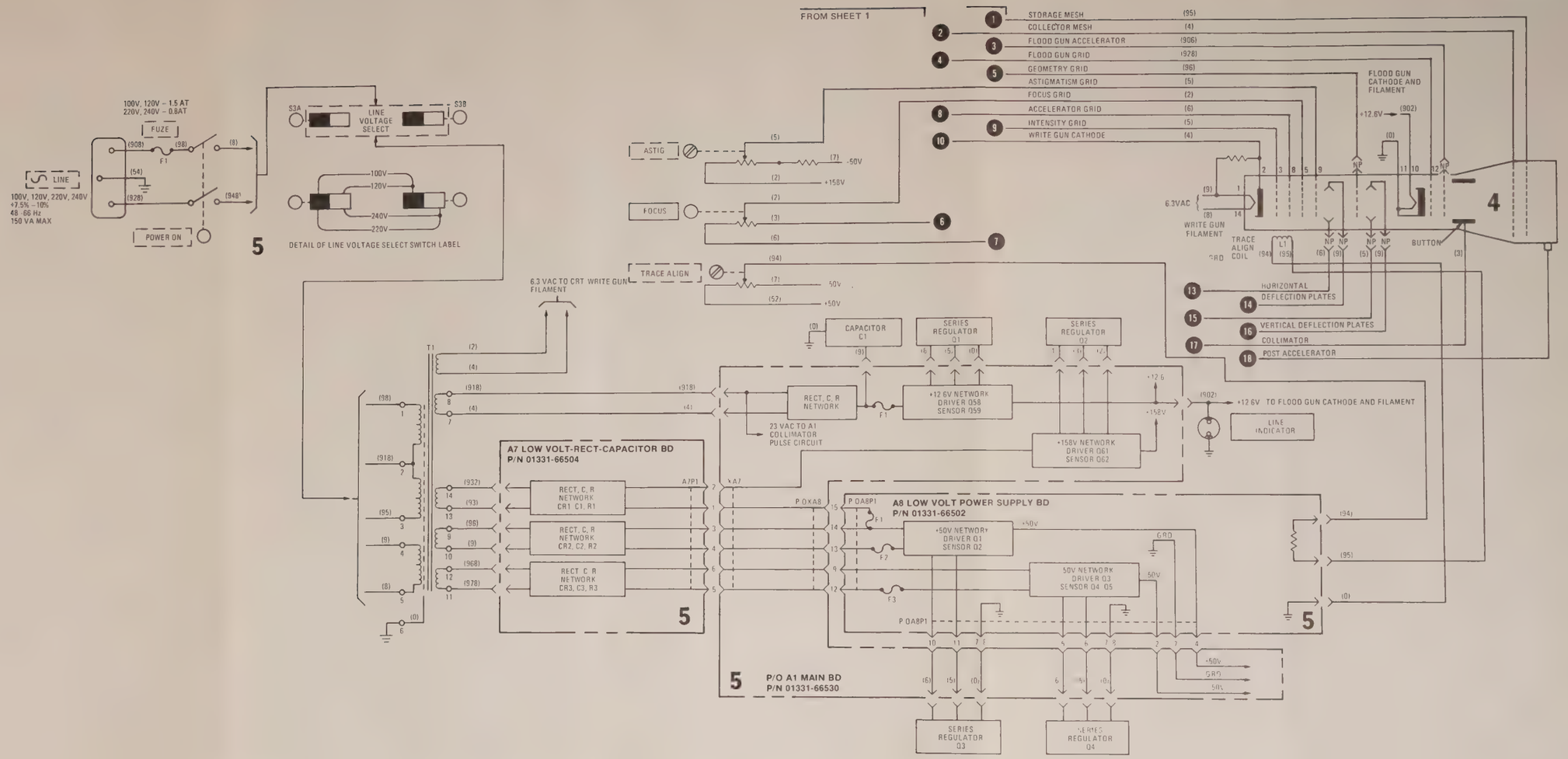


Figure 8-1.
Main Block Diagram, Model 1331A (Sheet 2 of 2)

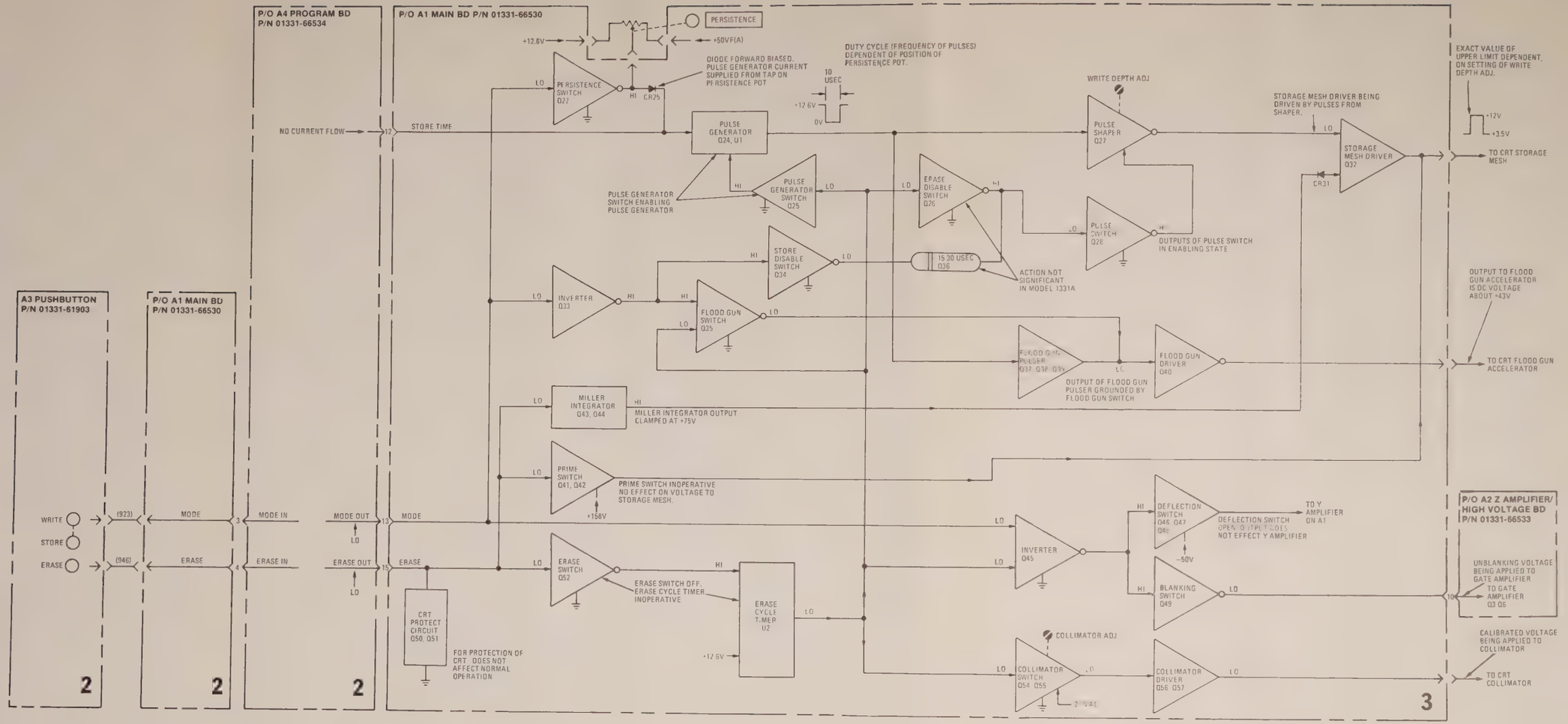


Figure 8-2. Block Diagram, Pulse Circuits in Write Mode

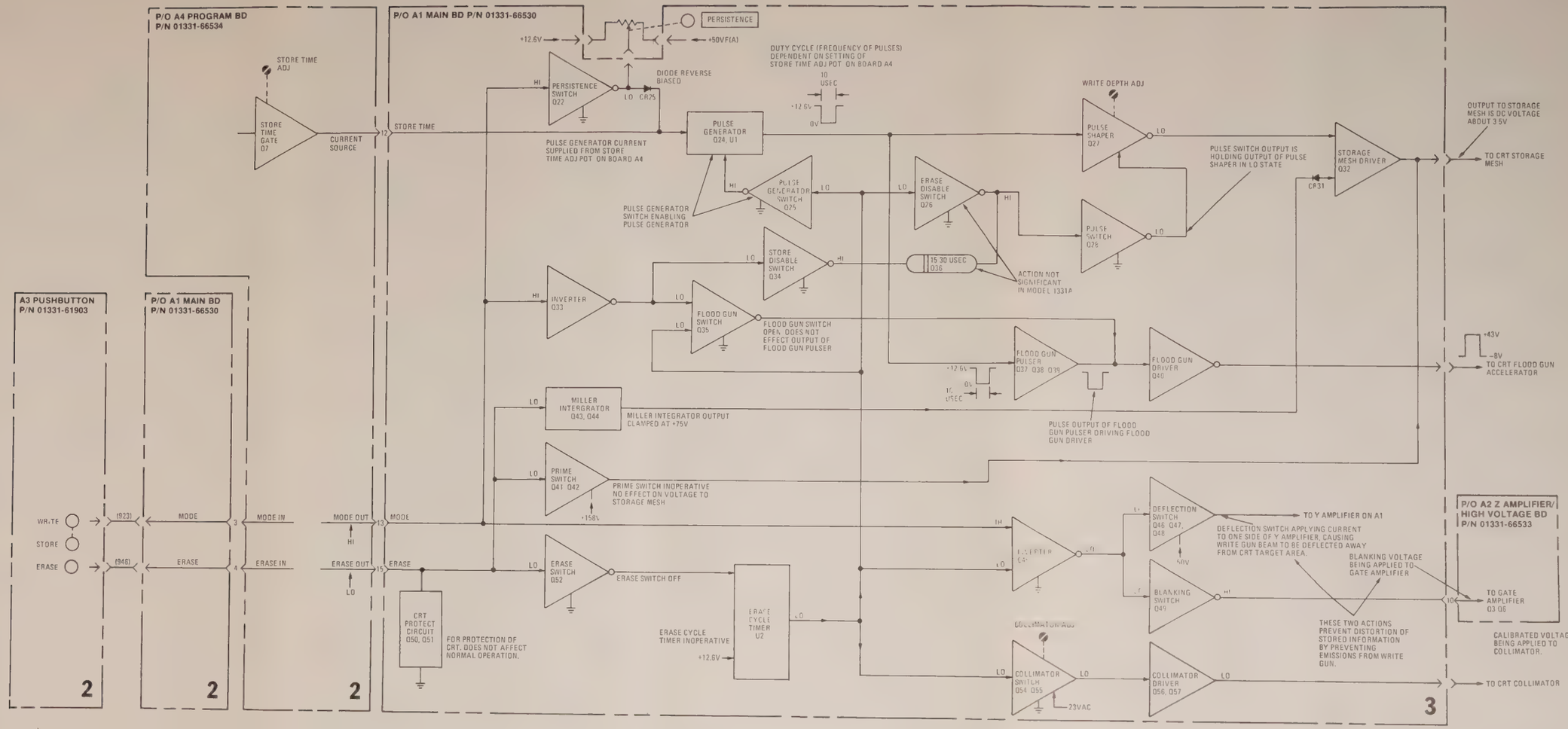

P/O A4 PROGRAM BD
P/N 01331-66534
P/O A1 MAIN BD P/N 01331-66530
A3 PUSHBUTTON
P/N 01331-61903
P/O A1 MAIN BD
P/N 01331-66530
P/O A2 Z AMPLIFIER/
HIGH VOLTAGE BD
P/N 01331-66533
STORE TIME ADJ
STORE TIME GATE Q7
CURRENT SOURCE
STORE TIME
PERSISTENCE
+12.6V
+50VF(A)
PERSISTENCE SWITCH Q22
DIODE REVERSE BIASED
CR25
DUTY CYCLE (FREQUENCY OF PULSES) DEPENDENT ON SETTING OF STORE TIME ADJ POT ON BOARD A4
10 USEC
PULSE GENERATOR CURRENT SUPPLIED FROM STORE TIME ADJ POT ON BOARD A4
PULSE GENERATOR Q24, U1
WRITE DEPTH ADJ
PULSE SHAPER Q27
PULSE SWITCH OUTPUT IS HOLDING OUTPUT OF PULSE SHAPER IN LO STATE
OUTPUT TO STORAGE MESH IS DC VOLTAGE ABOUT 3.5V
STORAGE MESH DRIVER Q32
CR31
TO CRT STORAGE MESH
PULSE GENERATOR SWITCH ENABLING PULSE GENERATOR
PULSE GENERATOR SWITCH Q25
ERASE DISABLE SWITCH Q76
PULSE SWITCH Q28
STORE DISABLE SWITCH Q34
15 30 USEC Q36
ACTION NOT SIGNIFICANT IN MODEL 1331A
INVERTER Q33
FLOOD GUN SWITCH Q35
FLOOD GUN SWITCH OPEN, DOES NOT EFFECT OUTPUT OF FLOOD GUN PULSER
FLOOD GUN PULSER Q37 Q38 Q39
FLOOD GUN DRIVER Q40
+43V
−8V
TO CRT FLOOD GUN ACCELERATOR
MILLER INTERGRATOR Q43, Q44
MILLER INTEGRATOR OUTPUT CLAMPED AT +75V
PULSE OUTPUT OF FLOOD GUN PULSER DRIVING FLOOD GUN DRIVER
PRIME SWITCH Q41 Q42
PRIME SWITCH INOPERATIVE NO EFFECT ON VOLTAGE TO STORAGE MESH
+158V
WRITE
STORE
ERASE
(923)
(948)
MODE
ERASE
MODE IN
ERASE IN
MODE OUT
ERASE OUT
HI
LO
ERASE SWITCH Q52
ERASE SWITCH OFF
CRT PROTECT CIRCUIT Q50, Q51
FOR PROTECTION OF CRT, DOES NOT AFFECT NORMAL OPERATION.
ERASE CYCLE TIMER INOPERATIVE
ERASE CYCLE TIMER U2
DEFLECTION SWITCH Q46 Q47, Q48
TO Y AMPLIFIER ON A1
DEFLECTION SWITCH APPLYING CURRENT TO ONE SIDE OF Y AMPLIFIER, CAUSING WRITE GUN BEAM TO BE DEFLECTED AWAY FROM CRT TARGET AREA.
BLANKING VOLTAGE BEING APPLIED TO GATE AMPLIFIER
BLANKING SWITCH Q49
THESE TWO ACTIONS PREVENT DISTORTION OF STORED INFORMATION BY PREVENTING EMISSIONS FROM WRITE GUN.
TO GATE AMPLIFIER Q3 Q6
CALIBRATED VOLTAGE BEING APPLIED TO COLLIMATOR.
COLLIMATOR ADJ
COLLIMATOR SWITCH Q54 Q55
23VAC
COLLIMATOR DRIVER Q56, Q57
TO CRT COLLIMATOR
2
2
2
3

Figure 8-3.
Block Diagram, Pulse Circuits in Store Mode

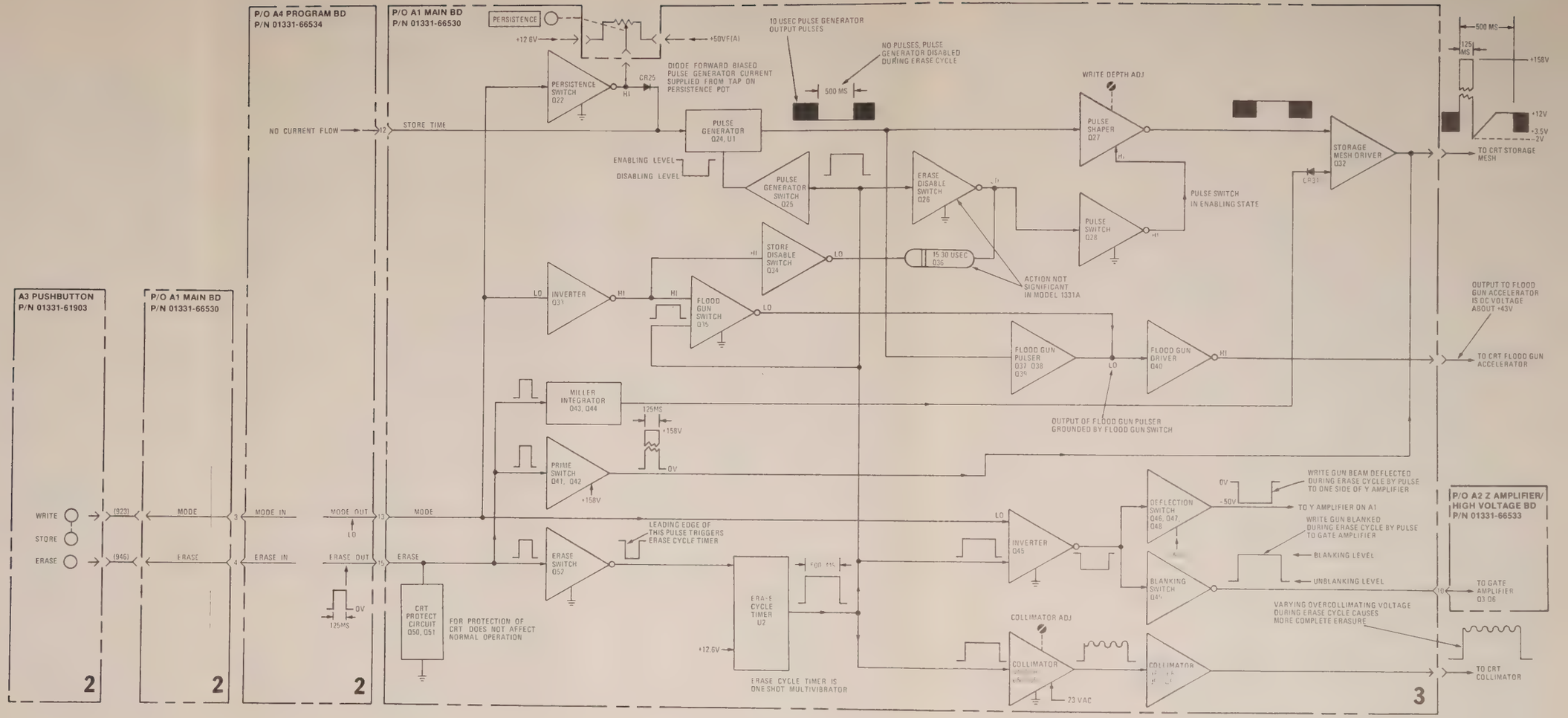
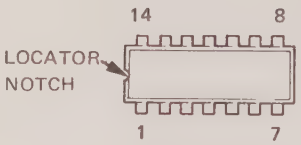


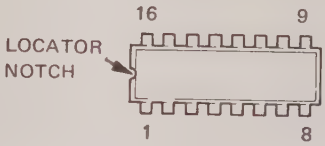
Figure 8-4. Block Diagram, Pulse Circuits in Erase Cycle

INTEGRATED CIRCUITS

14 PIN INTEGRATED CIRCUIT

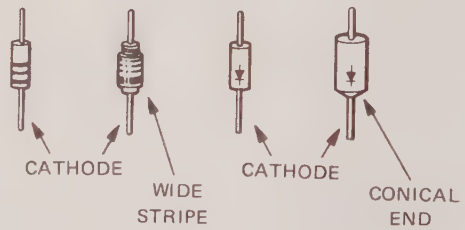


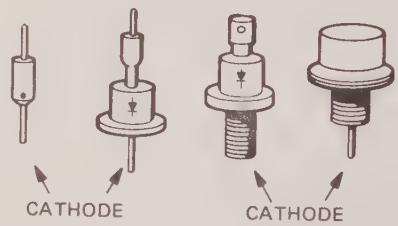
16 PIN INTEGRATED CIRCUIT

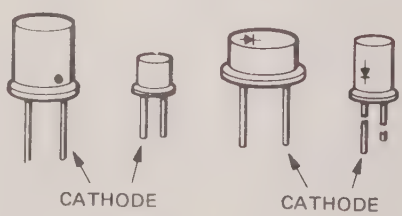


DIODES

DIODE SYMBOL

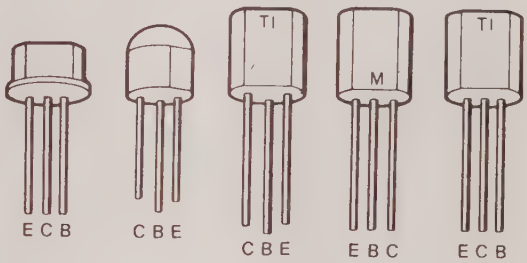




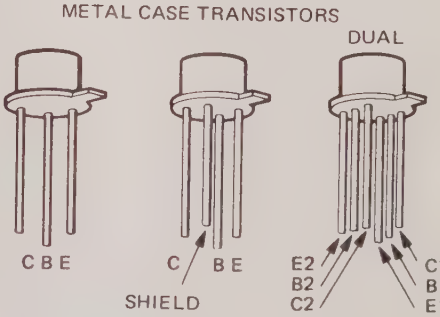


BI-POLAR TRANSISTORS

BLACK EPOXY (PLASTIC) TRANSISTORS



METAL CASE TRANSISTORS



FIELD EFFECT TRANSISTORS

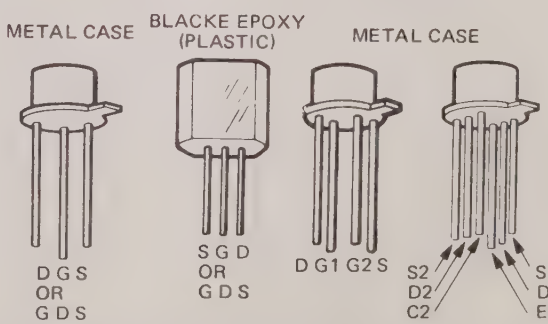
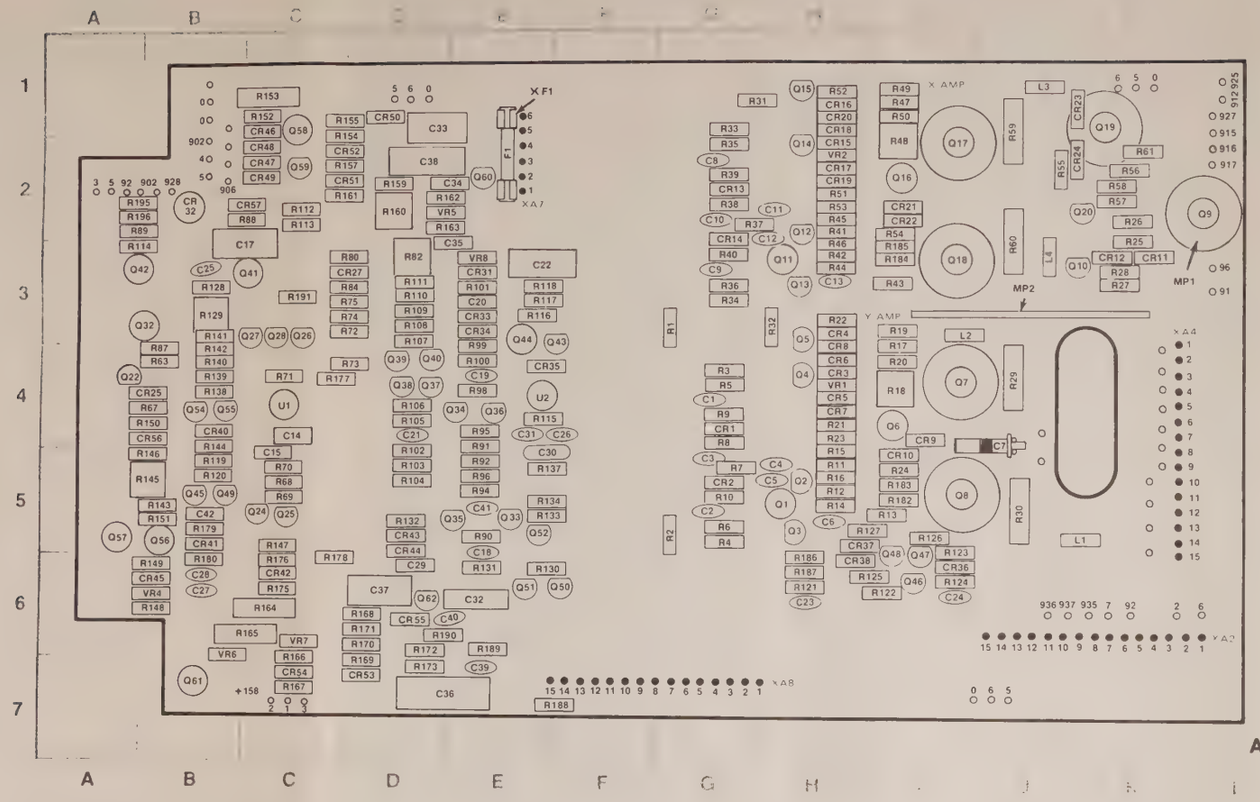


Figure 8-5.
Semiconductor Terminal Identification



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	G-4	CR9	I-4	MP1	L 2	Q54	B 4	R41	H 2	R104	D 5	R155	C 1		
C2	G-5	CR10	I-5	MP2	J 3	Q55	B 4	R42	H 3	R105	D-4	R157	C-2		
C3	G-5	CR11	K-3	Q1	H-5	Q56	B 5	R43	I 3	R106	D-4	R159	D-2		
C4	H-5	CR12	K-3	Q2	H 5	Q57	A 5	R44	H-3	R107	D-4	R160	D 2		
C5	H-5	CR13	G-2	Q3	H 3	Q58	C-1	R45	H-2	R108	D-3	R161	C 2		
C6	H-5	CR14	G-3	Q4	H 4	Q59	C-2	R46	H-3	R109	D-3	R162	D-2		
C7	J-4	CR15	H-2	Q5	H 3	Q60	E-2	R47	I 1	R110	D-3	R163	D-2		
C8	G-2	CR16	H-1	Q6	I 4	Q61	B-7	R48	I-2	R111	D-3	R164	C 6		
C9	G-3	CR17	H-2	Q7	I-4	Q62	D-6	R49	I 1	R112	C-2	R165	C 6		
C10	G-2	CR18	H-1	Q8	I-5	R1	G 3	R50	I-1	R113	C-2	R166	C-7		
C11	H-2	CR19	H-2	Q9	L-2	R2	G 5	R51	H-2	R114	A-3	R167	C 7		
C12	H-2	CR20	H-1	Q10	K-3	R3	G 4	R52	H-1	R115	E-4	R168	D-6		
C13	H-3	CR21	I-2	Q11	H-3	R4	G 5	R53	H 2	R116	E-3	R169	D 7		
C14	C 4	CR22	I 2	Q12	H 2	R5	G 4	R54	I 2	R117	E-3	R170	D 6		
C15	C-5	CR23	K-1	Q13	H-3	R6	G-5	R55	J 2	R118	E-3	R171	D 6		
C17	B-3	CR24	K-2	Q14	H-2	R7	G 5	R56	K 2	R119	B 5	R172	D-6		
C18	E-5	CR25	B-4	Q15	H-1	R8	G 4	R57	K 2	R120	B 5	R173	D 7		
C19	E-4	CR27	C-3	Q16	I-2	R9	G 4	R58	K 2	R121	H 6	R175	C 6		
C20	E-3	CR31	E-3	Q17	I-2	R10	G 5	R59	J 1	R122	I 6	R176	C 6		
C21	D-4	CR32	B-2	Q18	I-3	R11	H 5	R60	J 3	R123	I 6	R177	C 4		
C22	E-3	CR33	E-3	Q19	K-1	R12	H-5	R61	K 2	R124	I 6	R178	C 6		
C23	H-6	CR34	E-3	Q20	K-2	R13	I-5	R63	B-4	R125	I 6	R179	B 5		
C24	I-6	CR35	E-4	Q22	A-4	R14	H-5	R67	B 4	R126	I 5	R180	B 6		
C25	B-3	CR36	I-6	Q24	C-5	R15	H-5	R68	C 5	R127	I 5	R182	I 5		
C26	F-4	CR37	H-5	Q25	C-5	R16	H-5	R69	C-5	R128	B 3	R183	I 5		
C27	B-6	CR38	H-6	Q26	C 3	R17	I-4	R70	C 5	R129	B 3	R184	I 3		
C28	B-6	CR40	B-4	Q27	B 3	R18	I 4	R71	C-4	R130	D 5	R185	I 3		
C29	D-6	CR41	B-5	Q28	C 3	R19	I 3	R72	C-3	R131	E-6	R186	H 6		
C30	E-5	CR42	C-6	Q32	A 3	R20	I-4	R73	C-4	R132	D-5	R187	H 6		
C31	E-4	CR43	D 5	Q33	E 5	R21	H 4	R74	C 3	R133	E-5	R188	F 7		
C32	E-6	CR44	D 5	Q34	E 4	R22	H 3	R75	C-3	R134	E-5	R189	E 7		
C33	D 1	CR45	B 6	Q35	E 5	R23	H 4	R80	C 3	R137	E-5	R190	D-6		
C34	D-2	CR46	C 1	Q36	E 4	R24	I 5	R82	D-3	R138	B-4	R191	C 3		
C35	D-3	CR47	C 2	Q37	D 4	R25	K-3	R84	C 3	R139	B-4	R195	A-2		
C36	D-7	CR48	C 2	Q38	D 4	R26	K 2	R87	B-4	R140	B-4	R196	A-2		
C37	D-6	CR49	B-2	Q39	D 4	R27	K 3	R88	B 2	R141	B-3	U1	C-4		
C38	D-2	CR50	D 1	Q40	D 4	R28	K-3	R89	A 2	R142	B-4	U2	E-4		
C39	E-7	CR51	C 2	Q41	B 3	R29	J 4	R90	E 5	R143	B-5	VR1	H-4		
C40	E-6	CR52	C 2	Q42	A 3	R30	J 5	R91	E 4	R144	B 4	VR2	H-2		
C41	E-5	CR53	D-7	Q43	F-4	R31	G-1	R92	E-5	R145	B-5	VR4	B-6		
C42	B-5	CR54	C-7	Q44	E-3	R32	H-3	R94	E-5	R146	B-5	VR5	D 2		
CR1	G-4	CR55	D-6	Q45	B-5	R33	G-1	R95	E-4	R147	C-5	VR6	B 6		
CR2	G-5	CR56	B-4	Q46	I-6	R34	G-3	R96	E-5	R148	B-6	VR7	C 6		
CR3	H-4	CR57	B-2	Q47	I-6	R35	G-2	R98	E-4	R149	B-5	VR8	E 3		
CR4	H-3	F1	E-2	Q48	I-6	R36	G-3	R99	E-4	R150	B-4	XA2	L 6		
CR5	H-4	L1	K-5	Q49	B-5	R37	G-2	R100	E-4	R151	B-5	XA4	K 3		
CR6	H-4	L2	I-3	Q50	F-6	R38	G-2	R101	E-3	R152	C-1	XA7	E 2		
CR7	H-4	L3	J-1	Q51	E-6	R39	G-2	R102	D-5	R153	C-1	XA8	H 7		
CR8	H-4	L4	J-3	Q52	E-5	R40	G-3	R103	D-5	R154	C-1	XF1	E 1		

Figure 8-6. Service Information - X and Y Amplifiers - Assembly A1 (Sheet 1 of 2)

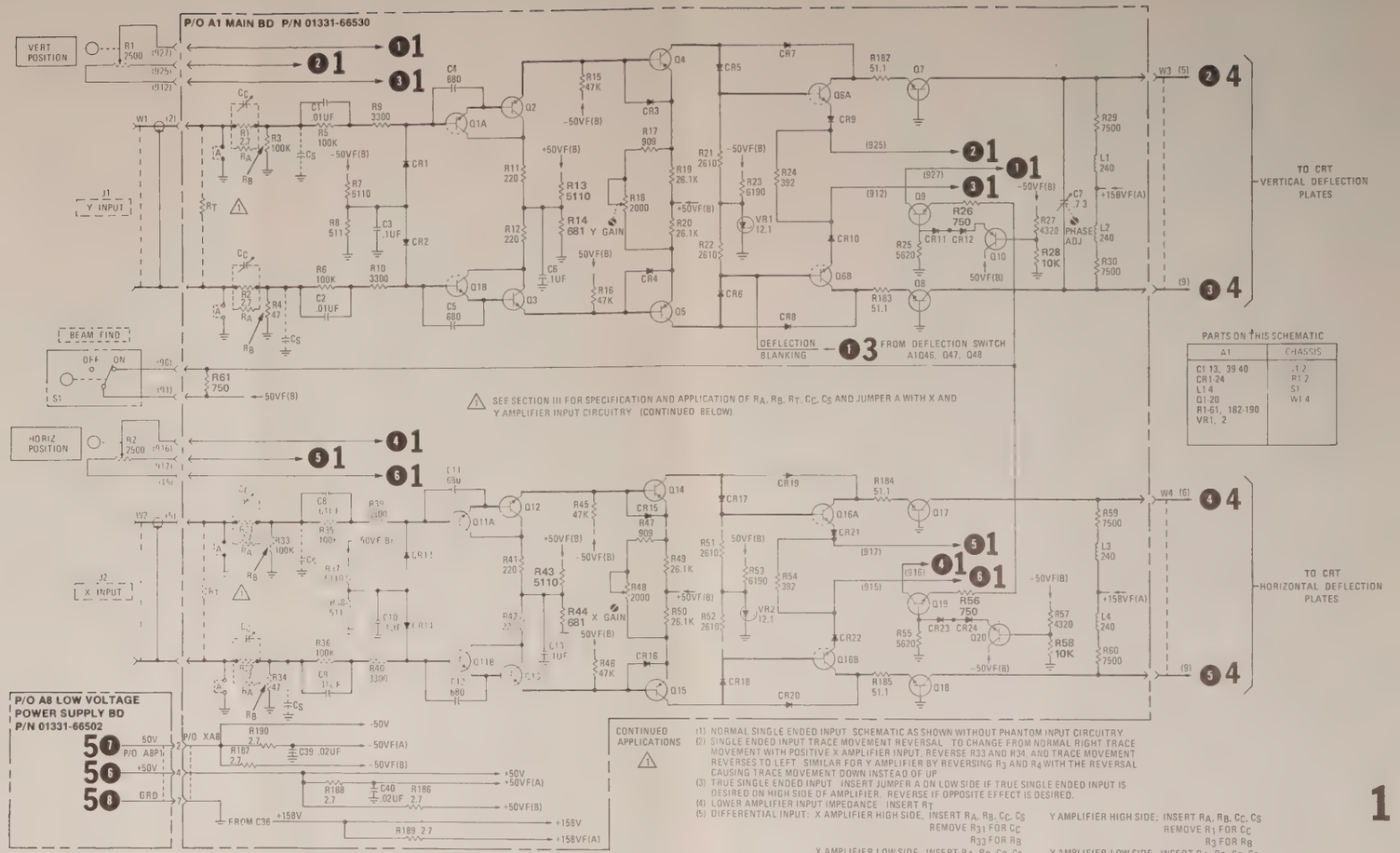
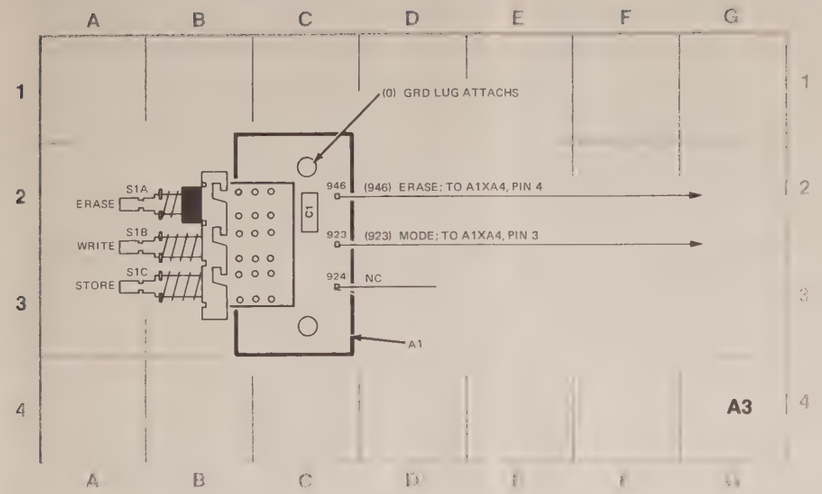
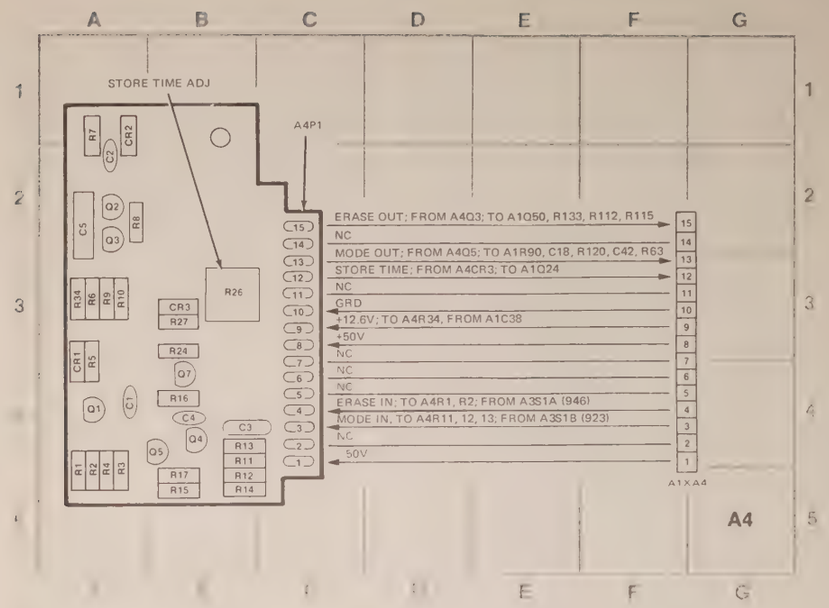

P/O A1 MAIN BD P/N 01331-66530
VERT POSITION
HORIZ POSITION
J1 Y INPUT
J2 X INPUT
BEAM FIND
OFF ON
S1
P/O A8 LOW VOLTAGE POWER SUPPLY BD P/N 01331-66502
P/O XA8
P/O A8P1
FROM C36
DEFLECTION BLANKING
FROM DEFLECTION SWITCH A1Q46, Q47, Q48
TO CRT VERTICAL DEFLECTION PLATES
TO CRT HORIZONTAL DEFLECTION PLATES
Y GAIN
X GAIN
PHASE ADJ
CONTINUED APPLICATIONS
PARTS ON THIS SCHEMATIC
A1 CHASSIS
C1 13, 39 40 J 2
CR1-24 P1 2
L1 4 S1
Q1-20 W1 4
R1-61, 182-190
VR1, 2
SEE SECTION III FOR SPECIFICATION AND APPLICATION OF RA, RB, RT, CC, CS AND JUMPER A WITH X AND Y AMPLIFIER INPUT CIRCUITRY (CONTINUED BELOW).
(1) NORMAL SINGLE ENDED INPUT SCHEMATIC AS SHOWN WITHOUT PHANTOM INPUT CIRCUITRY
(2) SINGLE ENDED INPUT TRACE MOVEMENT REVERSAL TO CHANGE FROM NORMAL RIGHT TRACE MOVEMENT WITH POSITIVE X AMPLIFIER INPUT, REVERSE R33 AND R34, AND TRACE MOVEMENT REVERSES TO LEFT SIMILAR FOR Y AMPLIFIER BY REVERSING R3 AND R4 WITH THE REVERSAL CAUSING TRACE MOVEMENT DOWN INSTEAD OF UP
(3) TRUE SINGLE ENDED INPUT INSERT JUMPER A ON LOW SIDE IF TRUE SINGLE ENDED INPUT IS DESIRED ON HIGH SIDE OF AMPLIFIER. REVERSE IF OPPOSITE EFFECT IS DESIRED.
(4) LOWER AMPLIFIER INPUT IMPEDANCE INSERT RT
(5) DIFFERENTIAL INPUT: X AMPLIFIER HIGH SIDE, INSERT RA, RB, CC, CS
REMOVE R31 FOR CC
R33 FOR RB
X AMPLIFIER LOW SIDE, INSERT RA, RB, CC, CS
REMOVE R32 FOR CC
R34 FOR RB
Y AMPLIFIER HIGH SIDE; INSERT RA, RB, CC, CS
REMOVE R1 FOR CC
R3 FOR RB
Y AMPLIFIER LOW SIDE, INSERT RA, RB, CC, CS
REMOVE R2 FOR CC
R4 FOR RB

Figure 8-6.
Service Information - X and Y Amplifiers - Assembly A1 (Sheet 2 of 2)

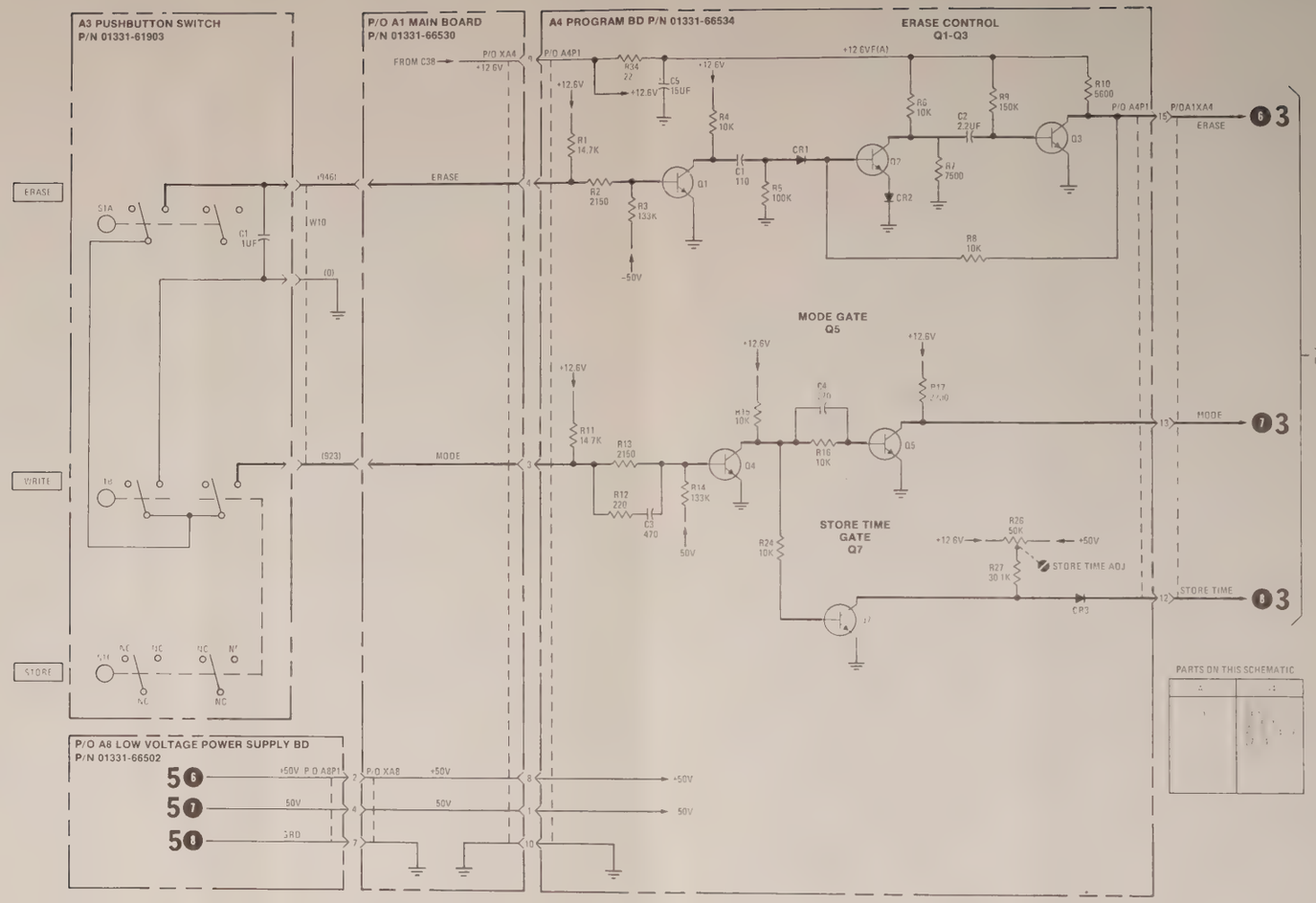


REF DESIG	GRID LOC
A1	C 2
S1A	A 2
S1B	A 2
S1C	A 3



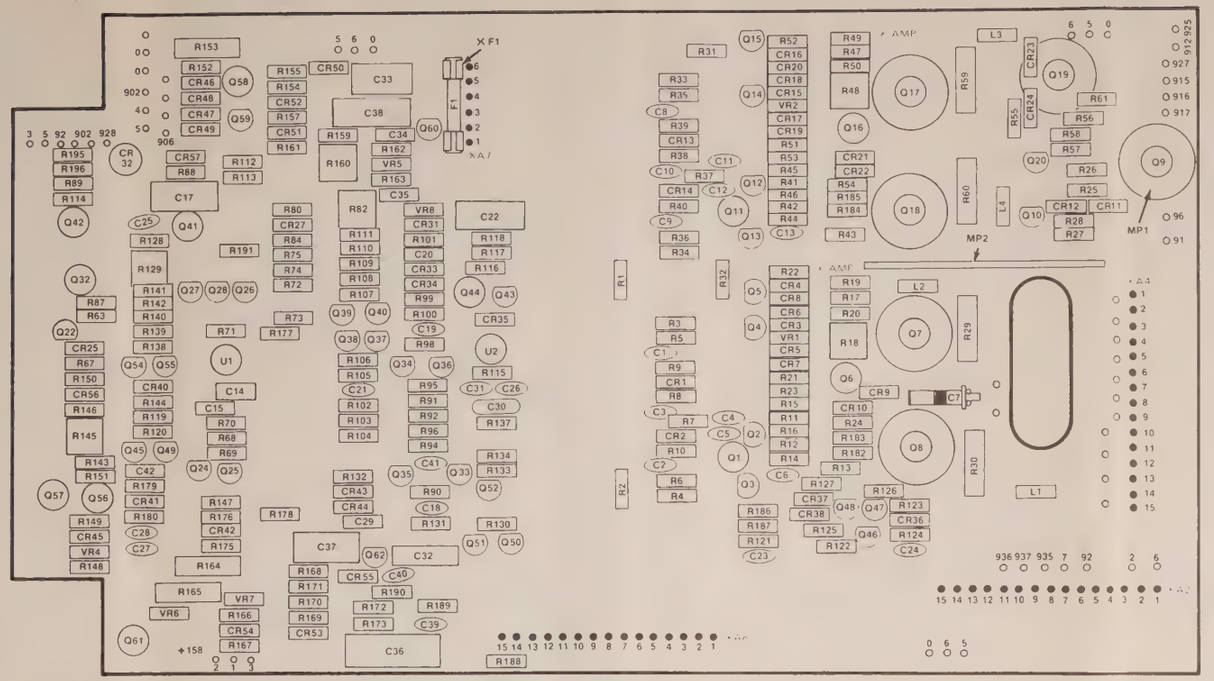
REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	A 4	R7	A 1
C2	A 1	R8	A 2
C3	A 4	R9	A 3
C4	B 4	R10	A 2
C5	A 2	R11	B 4
CR1	A 4	R12	B 5
CR2	A 1	R13	B 4
CR3	B 3	R14	B 5
Q1	A 4	R15	B 5
Q2	A 2	R16	B 4
Q3	A 2	R17	B 5
Q4	B 4	R24	B 3
Q5	B 4	R26	B 3
Q7	B 4	R27	B 3
R1	A 5	R34	A 2
R2	A 5		
R3	A 5		
R4	A 5		
R5	A 4		
R6	A 3		

Figure 8-7. Service Information - Program Circuits - Assemblies A3, A4 (Sheet 1 of 2)



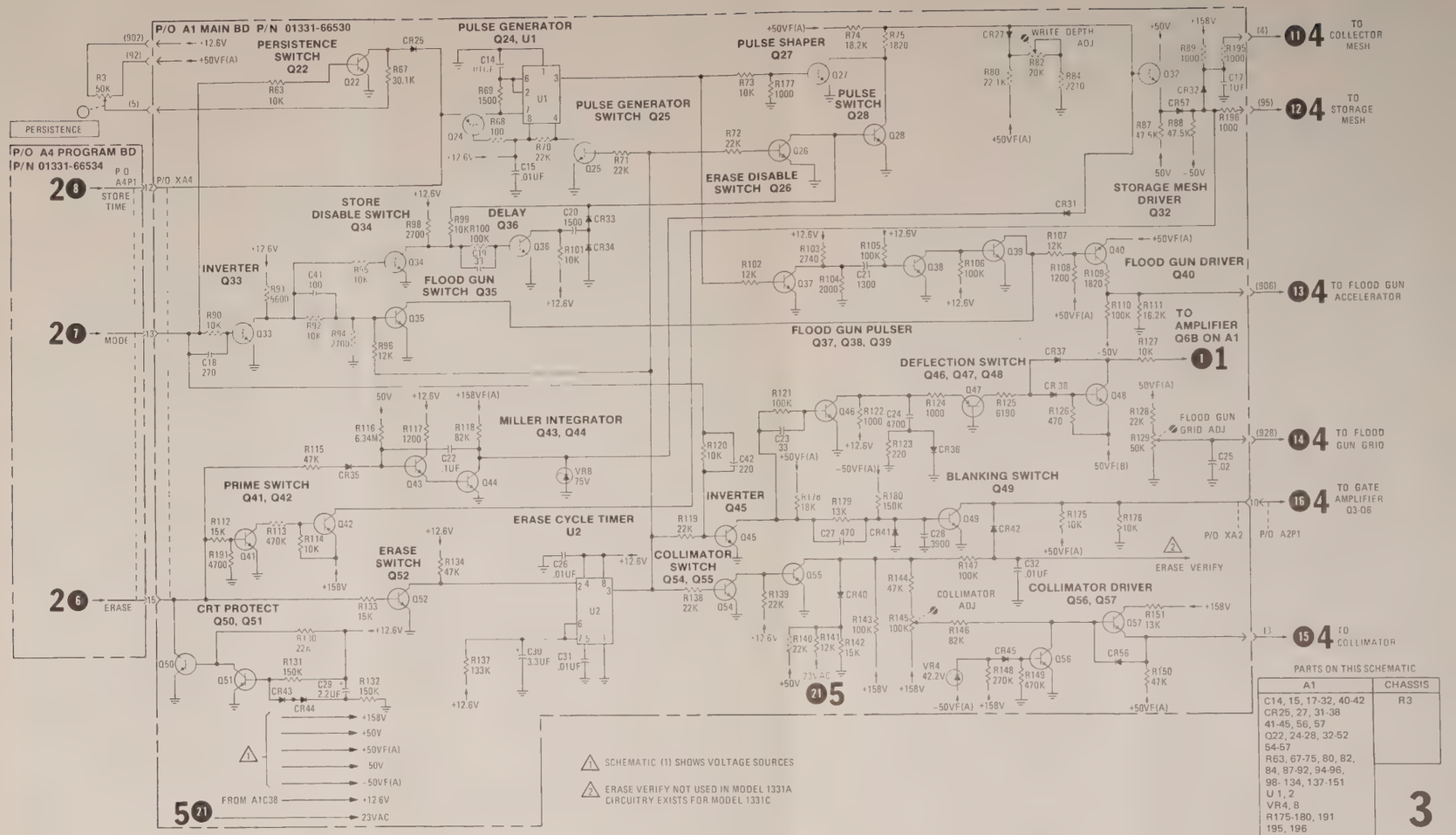
2

Figure 8-7.
Service Information - Program Circuits - Assemblies A3, A4 (Sheet 2 of 2)



REF DES	GRID LOC	REF DES	GRID LOC	REF DES	GRID LOC	REF DES	GRID LOC	REF DES	GRID LOC	REF DES	GRID LOC	REF DES	GRID LOC
C1	G 4	CR9	I 4	MP1	L 2	Q54	B 4	R41	H 2	R104	D 5	R155	C 1
C2	G 5	CR10	I 5	MP2	J 3	Q55	B 4	R42	H 3	R105	D 4	R157	C 2
C3	G 5	CR11	K 3	Q1	H 5	Q56	B 5	R43	I 3	R106	D 4	R159	D 2
C4	H 5	CR12	K 3	Q2	H 5	Q57	A 5	R44	H 3	R107	D 4	R160	D 2
C5	H 5	CR13	G 2	Q3	H 3	Q58	C 1	R45	H 2	R108	D 3	R161	C 2
C6	H 5	CR14	G 3	Q4	H 4	Q59	C 2	R46	H 3	R109	D 3	R162	D 2
C7	J 4	CR15	H 2	Q5	H 3	Q60	E 2	R47	I 1	R110	D 3	R163	D 2
C8	G 2	CR16	H 1	Q6	I 4	Q61	B 7	R48	I 2	R111	D 3	R164	C 6
C9	G 3	CR17	H 2	Q7	I 4	Q62	D 6	R49	I 1	R112	C 2	R165	C 6
C10	G 2	CR18	H 1	Q8	I 5	R1	G 3	R50	I 1	R113	C 2	R166	C 7
C11	H 2	CR19	H 2	Q9	L 2	R2	G 5	R51	H 2	R114	A 3	R167	C 7
C12	H 2	CR20	H 1	Q10	K 3	R3	G 4	R52	H 1	R115	E 4	R168	D 6
C13	H 3	CR21	I 2	Q11	H 3	R4	G 5	R53	H 2	R116	E 3	R169	D 7
C14	C 4	CR22	I 2	Q12	H 2	R5	G 4	R54	I 2	R117	E 3	R170	D 6
C15	C 5	CR23	K 1	Q13	H 3	R6	G 5	R55	J 2	R118	E 3	R171	D 6
C17	B 3	CR24	K 2	Q14	H 2	R7	G 5	R56	K 2	R119	B 5	R172	D 6
C18	E 5	CR25	B 4	Q15	H 1	R8	G 4	R57	K 2	R120	B 5	R173	D 7
C19	E 4	CR27	C 3	Q16	I 2	R9	G 4	R58	K 2	R121	H 6	R175	C 6
C20	E 3	CR31	E 3	Q17	I 2	R10	G 5	R59	J 1	R122	I 6	R176	C 6
C21	D 4	CR32	B 2	Q18	I 3	R11	H 5	R60	J 3	R123	I 6	R177	C 4
C22	E 3	CR33	E 3	Q19	K 1	R12	H 5	R61	K 2	R124	I 5	R178	C 6
C23	H 6	CR34	E 3	Q20	K 2	R13	I 5	R63	B 4	R125	I 6	R179	B 5
C24	I 6	CR35	E 4	Q22	A 4	R14	H 5	R67	B 4	R126	I 5	R180	B 6
C25	B 3	CR36	I 6	Q24	C 5	R15	H 5	R68	C 5	R127	I 5	R182	I 5
C26	F 4	CR37	H 5	Q25	C 5	R16	H 5	R69	C 5	R128	B 3	R183	I 5
C27	B 6	CR38	H 5	Q26	C 3	R17	I 4	R70	C 5	R129	B 3	R184	I 3
C28	B 6	CR40	B 4	Q27	B 3	R18	I 4	R71	C 4	R130	D 5	R185	I 3
C29	D 6	CR41	B 5	Q28	C 3	R19	I 3	R72	C 3	R131	E 6	R186	H 6
C30	E 5	CR42	C 6	Q32	A 3	R20	I 4	R73	C 4	R132	D 5	R187	H 6
C31	E 4	CR43	D 5	Q33	E 5	R21	H 4	R74	C 3	R133	E 5	R188	F 7
C32	E 6	CR44	D 5	Q34	E 4	R22	H 3	R75	C 3	R134	E 5	R189	E 7
C33	D 1	CR45	B 6	Q35	E 5	R23	H 4	R80	C 3	R137	E 5	R190	D 6
C34	D 2	CR46	C 1	Q36	E 4	R24	I 5	R82	D 3	R138	B 4	R191	C 3
C35	D 3	CR47	C 2	Q37	D 4	R25	K 3	R84	C 3	R139	B 4	R195	A 2
C36	D 7	CR48	C 2	Q38	D 4	R26	K 2	R87	B 4	R140	B 4	R196	A 2
C37	D 6	CR49	C 2	Q39	D 4	R27	K 3	R88	B 2	R141	B 3	U1	C 4
C38	D 2	CR50	D 1	Q40	D 4	R28	K 3	R89	A 2	R142	B 4	U2	E 4
C39	E 7	CR51	C 2	Q41	B 3	R29	J 4	R90	E 5	R143	B 5	VR1	H 4
C40	E 6	CR52	C 2	Q42	A 3	R30	J 5	R91	E 4	R144	B 4	VR2	H 2
C41	E 5	CR53	D 7	Q43	F 4	R31	G 1	R92	E 5	R145	B 5	VR4	B 6
C42	B 5	CR54	C 7	Q44	E 3	R32	H 3	R94	E 5	R146	B 5	VR5	D 2
CR1	G 4	CR55	D 6	Q45	B 5	R33	G 1	R95	E 4	R147	C 5	VR6	B 6
CR2	G 5	CR56	B 4	Q46	I 6	R34	G 3	R96	E 5	R148	B 6	VR7	C 6
CR3	H 4	CR57	B 2	Q47	I 6	R35	G 2	R98	E 4	R149	B 6	VR8	E 3
CR4	H 3	F1	E 2	Q48	I 6	R36	G 3	R99	E 4	R150	B 4	XA2	L 6
CR5	H 4	L1	K 5	Q49	B 5	R37	G 2	R100	E 4	R151	B 5	XA4	K 3
CR6	H 4	L2	I 3	Q50	F 6	R38	G 2	R101	E 3	R152	C 1	XA7	E 2
CR7	H 4	L3	J 1	Q51	E 6	R39	G 2	R102	D 5	R153	C 1	XA8	H 7
CR8	H 4	L4	J 3	Q52	E 5	R40	G 3	R103	D 5	R154	C 1	XF1	E 1

Figure 8-8. Service Information - Pulse Circuits - Assembly A1 (Sheet 1 of 2)

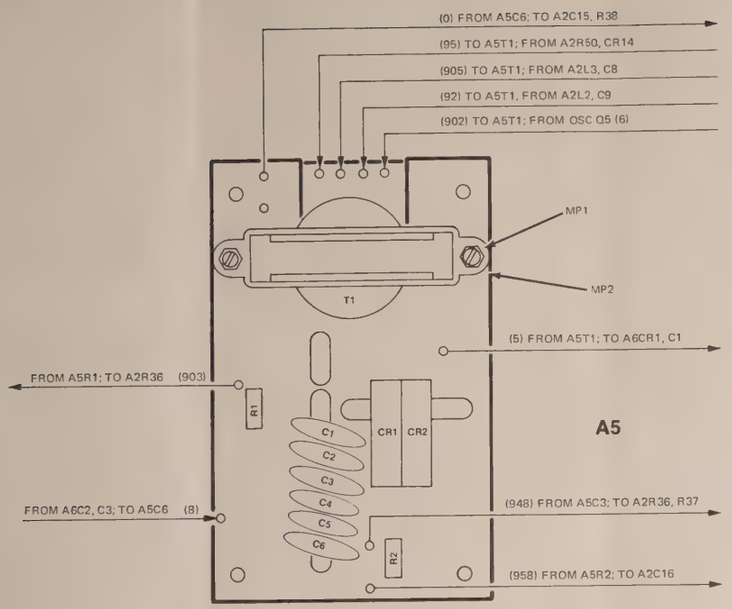


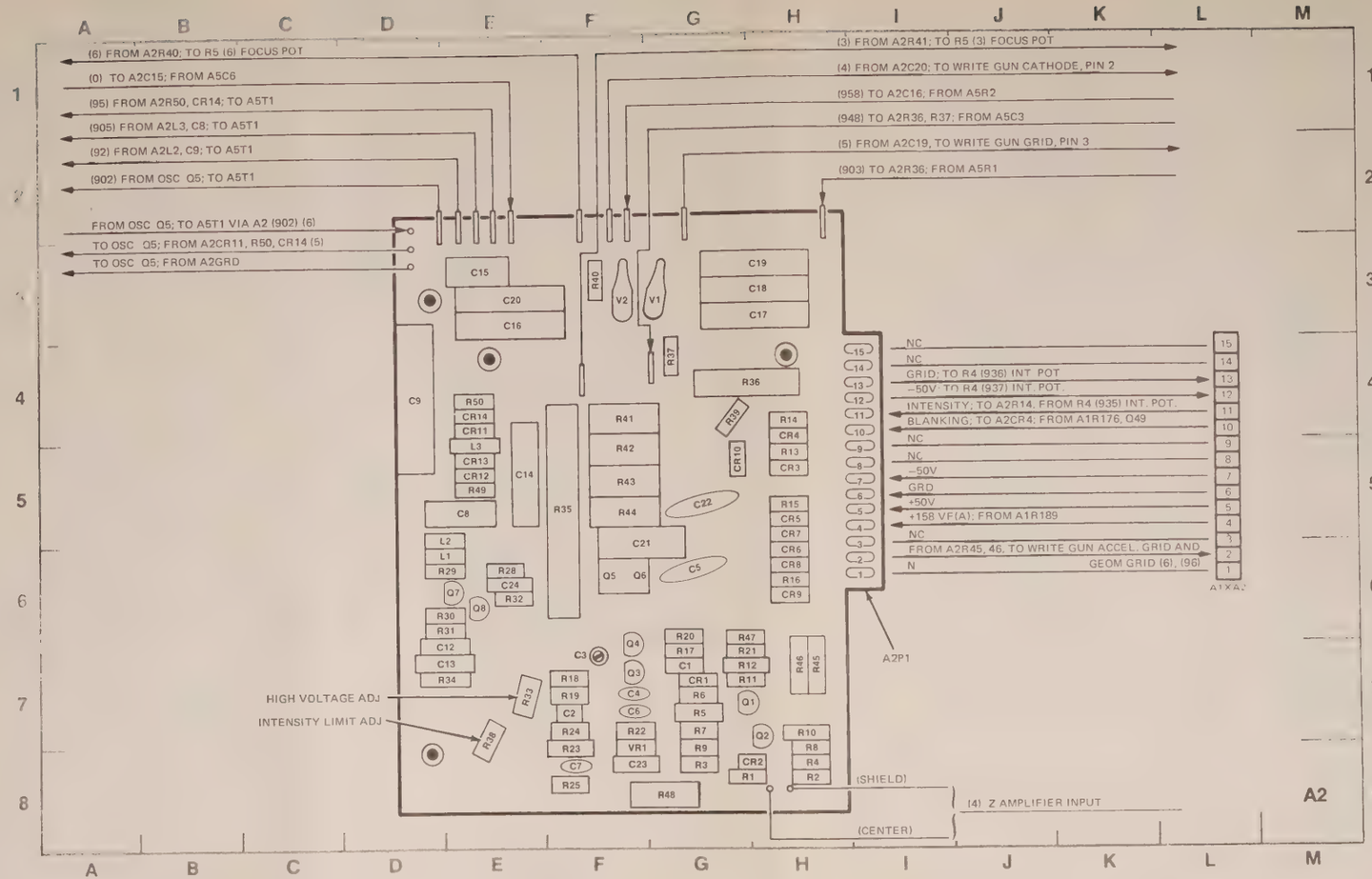
PARTS ON THIS SCHEMATIC

A1	CHASSIS
C14, 15, 17-32, 40-42 CR25, 27, 31-38 41-45, 56, 57 Q22, 24-28, 32-52 54-57 R63, 67-75, 80, 82, 84, 87-92, 94-96, 98-134, 137-151 U1, 2 VR4, 8 R175-180, 191 195, 196	R3

3

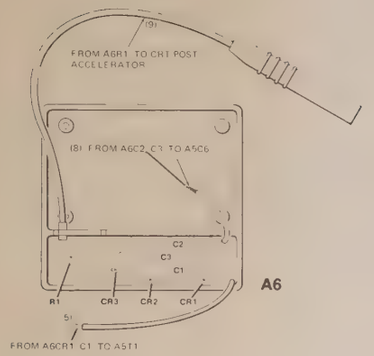
Figure 8-8.
Service Information - Pulse Circuits - Assembly A1 (Sheet 2 of 2)





REF DES/G	GRID LOC	REF DES/G	GRID LOC
C1	G-7	R3	G-8
C2	F-7	R4	H-8
C3	F-7	R5	G-7
C4	F-7	R6	G-7
C5	G-6	R7	G-7
C6	F-7	R8	H-8
C7	F-8	R9	G-8
C8	E-5	R10	H-7
C9	D-4	R11	G-7
C12	E-6	R12	G-7
C13	E-7	R13	H-5
C14	E-5	R14	H-4
C15	E-3	R15	H-5
C16	E-3	R16	H-6
C17	H-3	R17	G-7
C18	H-3	R18	F-7
C19	H-3	R19	F-7
C20	E-3	R20	G-6
C21	F-6	R21	G-7
C22	G-5	R22	F-7
C23	F-8	R23	F-8
C24	E-6	R24	F-7
CR1	G-7	R25	F-8
CR2	G-8	R28	E-6
CR3	H-5	R29	E-6
CR4	H-4	R30	E-6
CR5	H-5	R31	E-6
CR6	H-6	R32	E-6
CR7	H-5	R33	E-7
CR8	H-6	R34	E-7
CR9	H-6	R35	F-5
CR10	G-5	R36	H-4
CR11	E-4	R37	G-4
CR12	E-5	R38	E-7
CR13	E-5	R39	G-4
CR14	E-4	R40	F-3
L1	E-6	R41	F-4
L2	E-5	R42	F-5
L3	E-5	R43	F-5
Q1	G-7	R44	F-5
Q2	H-7	R45	H-7
Q3	F-7	R46	H-7
Q4	F-6	R47	H-6
Q5	F-6	R48	G-8
Q6	F-6	R49	E-5
Q7	E-6	R50	E-4
Q8	E-6	V1	G-3
R1	G-8	V2	F-3
R2	H-8	VR1	F-8

Figure 8-9. Service Information - Z Amplifier, High Voltage Power Supply - Assemblies A2, A5, A6 (Sheet 1 of 2)



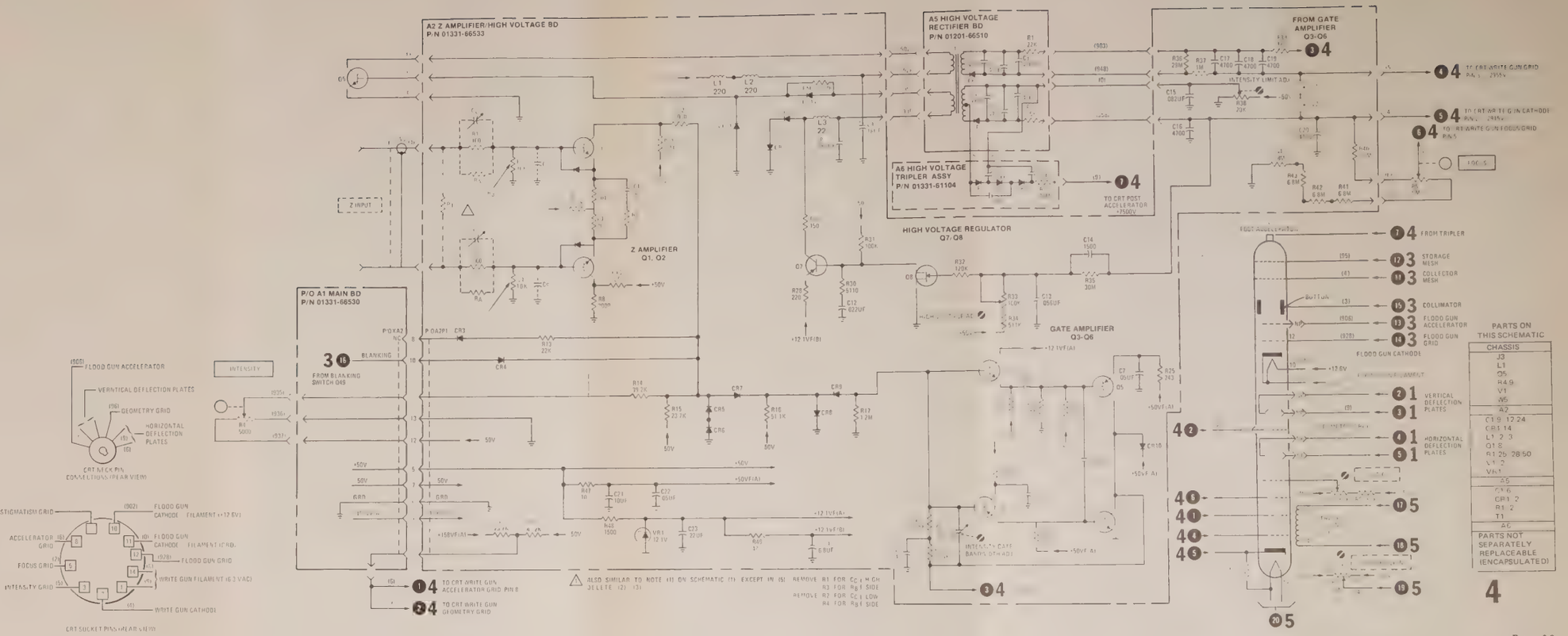
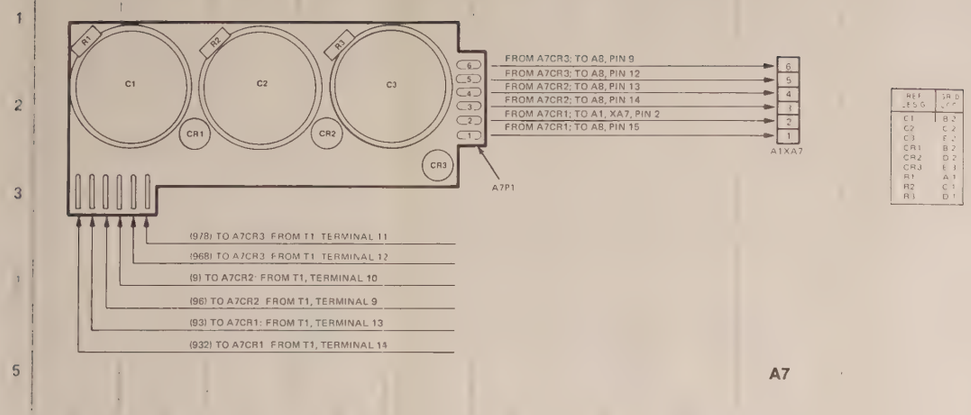
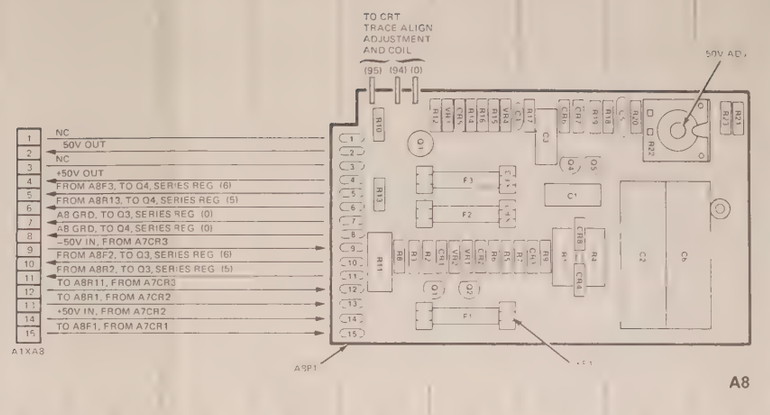


Figure 8-9.
Service Information - Z Amplifier/High Voltage Power Supply - Assemblies A2, A5, A6 (Sheet 2 of 2)

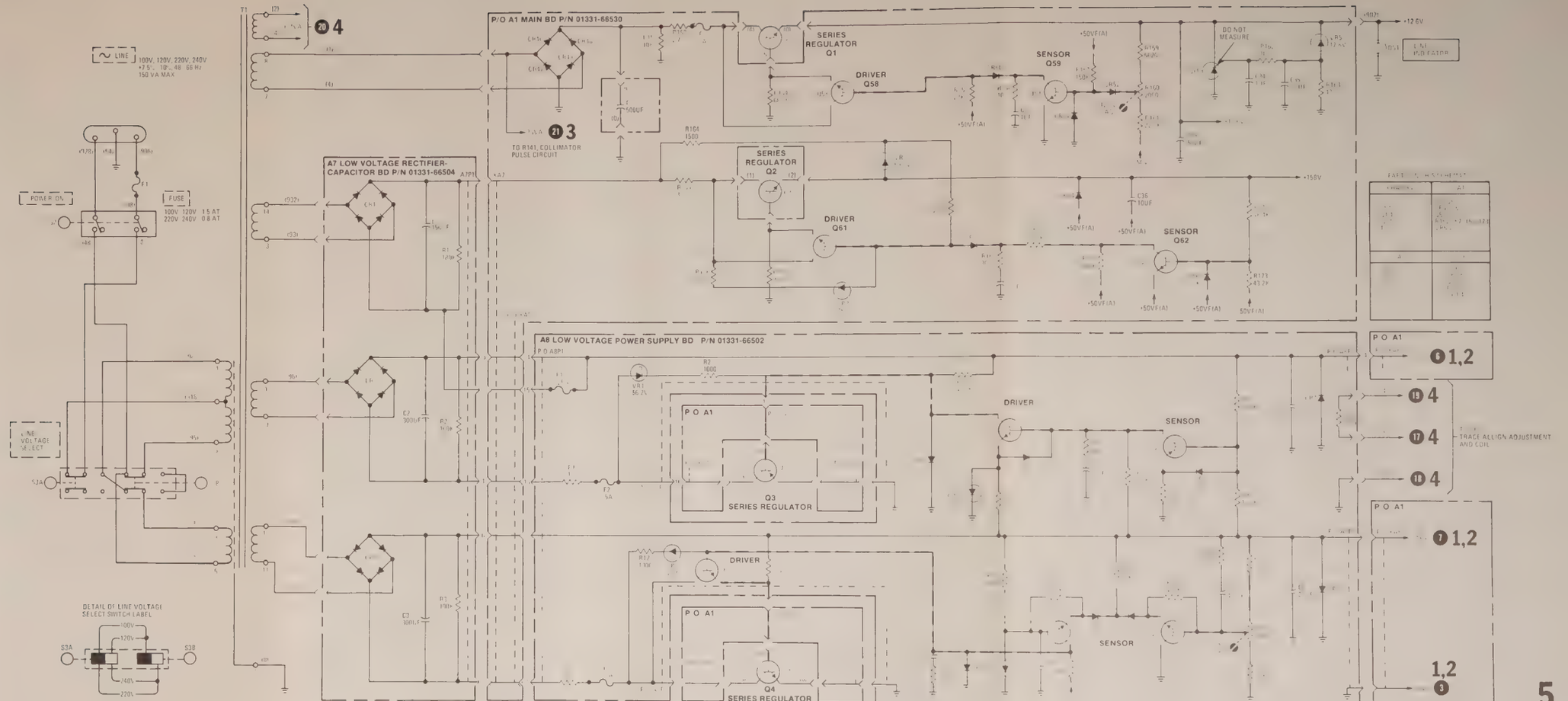


REF DES	GRID LOC
C1	B 2
C2	C 2
C3	E 2
CR1	B 2
CR2	D 2
CR3	E 1
R1	A 1
R2	C 1
R3	D 1


TO CRT TRACE ALIGN ADJUSTMENT AND COIL
(95) (94) (0)
50V ADJ
NC
50V OUT
NC
+50V OUT
FROM A8F3, TO Q4, SERIES REG (6)
FROM A8R13, TO Q4, SERIES REG (5)
A8 GRD, TO Q3, SERIES REG (0)
A8 GRD, TO Q4, SERIES REG (0)
–50V IN, FROM A7CR3
FROM A8F2, TO Q3, SERIES REG (6)
FROM A8R2, TO Q3, SERIES REG (5)
TO A8R11, FROM A7CR3
TO A8R1, FROM A7CR2
+50V IN, FROM A7CR2
TO A8F1, FROM A7CR1
A1XA8
A8P1
A8

REF DES	GRID LOC	REF DES	GRID LOC
C1	G 1	R5	F 4
C2	H 4	R6	F 4
C3	G 2	R7	G 4
C4	F 2	R8	E 4
C5	H 2	R9	G 4
C6	H 4	R10	E 2
CR1	F 4	R11	E 4
CR2	F 4	R12	F 2
CR3	G 4	R13	E 3
CR4	G 4	R14	F 2
CR5	F 2	R15	F 2
CR6	G 2	R16	F 2
CR7	G 2	R17	G 2
CR8	G 3	R18	H 2
F1	F 4	R19	G 2
F2	F 3	R20	H 2
F3	F 3	R21	2
Q1	F 4	R22	H 2
Q2	F 4	R23	12
Q3	E 2	VR1	F 4
Q4	G 1	VR2	F 4
35	G 3	VR3	F 2
R1	G 4	VR4	F 2
R2	F 4	XF1	F 4
R3	E 4	XF2	F 1
R4	G 4	XF3	F

Figure 8-10. Service Information - Low Voltage Power Supply - Assemblies A7, A8 (Sheet 1 of 2)



5

Figure 8-10.
Service Information - Low Voltage Power Supply - Assemblies A7, A8 (Sheet 2 of 2)
8-21/(8-22 blank)

MANUAL CHANGES

MODEL 1331A

X-Y DISPLAY

Manual Serials Prefixed: 1424A
Manual Printed: JUNE 1974

Make all changes listed below as Errata. Check the following table for your instrument serial prefix and/or serial number and make listed change(s) to the manual:

Serial Prefix or Number	Make Changes	Serial Prefix or Number	Make Changes
1446A	1		
1448A	1, 2		
1513A	1 thru 3		
1536A	1 thru 3		

ERRATA

Page 5-7, paragraph 5-29,
Add following statement to step c:
Output shall be +50V ± 1V.

Page 5-9, figure 5-8,
Replace with figure 5-8 as follows.

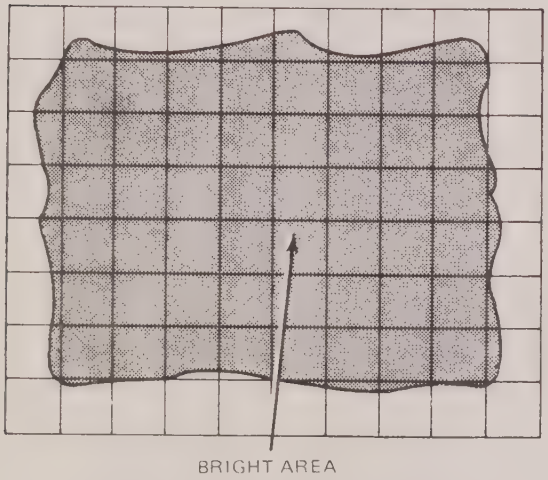


Figure 5-8. Overcollimated CRT

Table 6-2,
Add: J4, HP Part No. 1251-2357, CONNECTOR-AC PWR HP9 MALE FLG MTG, Mfr Code 00180, Mfr Part No. 6061-3.
L1: Change HP Part No. and Mfr Part No. to 01200-66001.
MP18: Change reference designator to MP19.
MP19: Change reference designator to MP18 and change HP Part No. and Mfr Part No. to 01331-44701.
Δ MP31: Change HP Part No. and Mfr Part No. to 5060-0519.

Table 6-2 (Cont'd),
Add: S1, HP Part No. 3101-0890, SWITCH: TGL SPDT, Mfr Code 28480, Mfr Part No. 3101-0890.
Add: S3, HP Part No. 3101-1609, SWITCH: SLIDE 2-DPDT, Mfr Code 82389, Mfr Part No. 11E-1036.
TB1: Change HP Part No. and Mfr Part No. to 01200-26521.
W6: Change to HP Part No. 8120-1992, CABLE, MALE NEMA, Mfr Code 28480, Mfr Part No. 8120-1992.
Add: A1Q35, HP Part No. 1854-0358, TRANSISTOR NPN SI PD=310MW FT=60MHZ, Mfr Code 28480, Mfr Part No. 1854-0358.
A1Q43: Change to HP Part No. 1854-0691, TRANSISTOR NPN SI, Mfr Code 28480, Mfr Part No. 1854-0691.
A1Q57: Change to HP Part No. 1854-0071, TRANSISTOR NPN SI PD=300MW FT=200MHZ, Mfr Code 28480, Mfr Part No. 1854-0071.
Delete: A2C13.
Δ A4C1: Change to HP Part No. 0140-0156, CAPACITOR-FXD 1500 PF +—2% 300WVDC, Mfr Code 72136, Mfr Part No. DM19F152G0300WV1CR.
Add: A4C6, HP Part No. 0140-0196, C:FXD MICA 150 PF 5%, Mfr Code 72136, Mfr Part No. RDM15F151J3C.
Add: A4C7, HP Part No. 0160-2145, C:FXD CER 5000 PF +80—20% 100VDCW, Mfr Code 91418, Mfr Part No. TA.
Δ A4R4: Change to HP Part No. 0684-1021, RESISTOR-FXD 1K 10% .25W CC TUBULAR, Mfr Code 01121, Mfr Part No. CB1021.
Δ A4R5: Change to HP Part No. 0757-0437, RESISTOR-FXD 4.75K 1% .125W F TUBULAR, Mfr Code 24546, Mfr Part No. C4-1/8-TO-4751-F.

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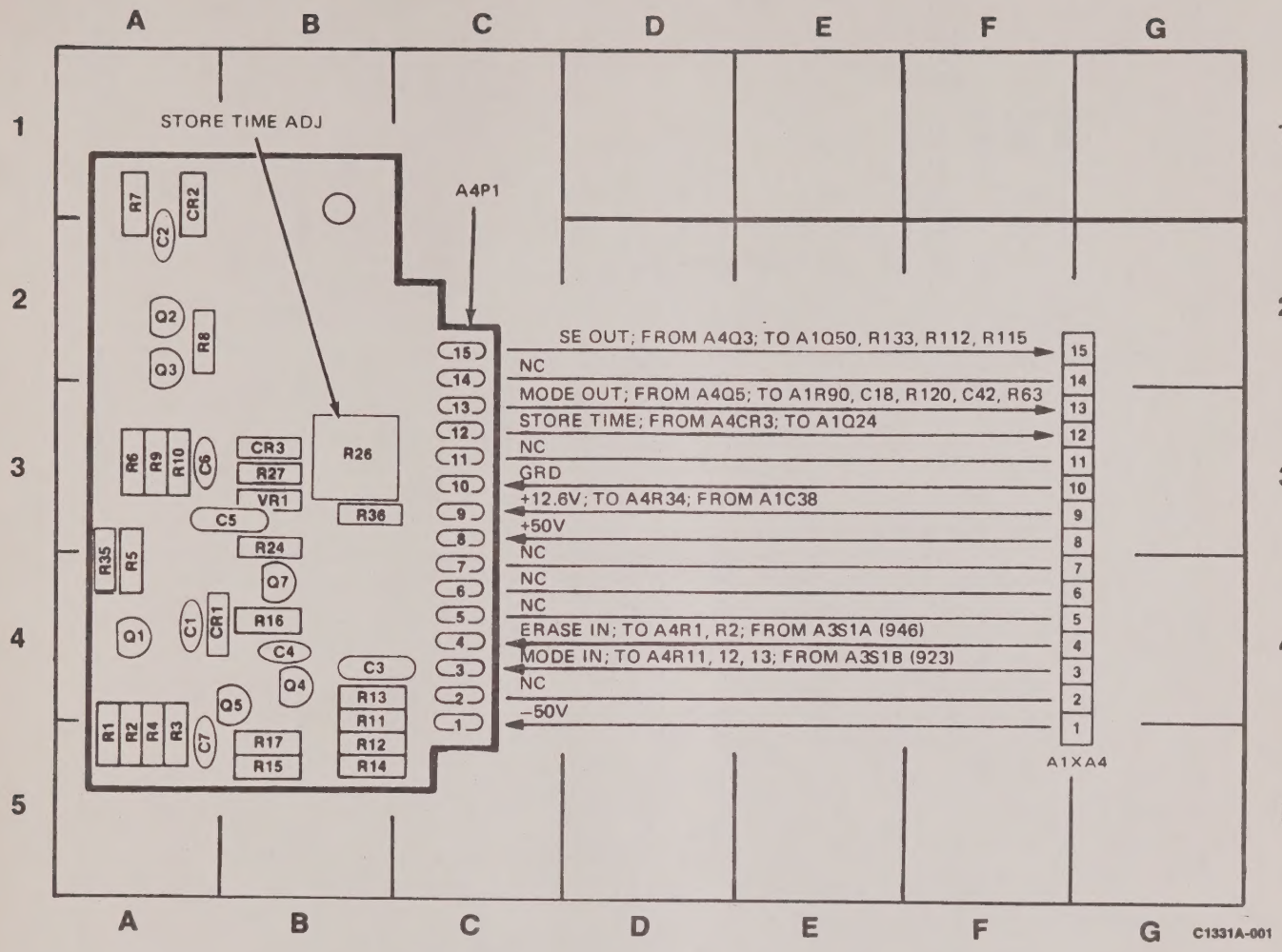
Δ = Latest additions to this change sheet.
This change sheet supersedes all prior change sheets for this manual.

Supplement A for
01331-90906



REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	A-4	R5	A-4
C2	A-2	R6	A-3
C3	B-4	R7	A-1
C4	B-4	R8	A-2
C5	B-3	R9	A-3
C6	B-6	R10	A-3
C7	A-5	R11	B-4
CR1	A-4	R12	B-5
CR2	A-1	R13	B-4
CR3	B-3	R14	B-5
Q1	A-4	R15	B-5
Q2	A-2	R16	B-4
Q3	A-2	R17	B-5
Q4	B-4	R24	B-3
Q5	B-4	R26	B-3
Q7	B-4	R27	B-3
R1	A-5	R35	A-3
R2	A-5	R36	B-3
R3	A-5	VR1	B-3
R4	A-5		

Figure 8-7. Service Information - Program Circuits - Assemblies A3, A4 (Sheet 1 of 2)

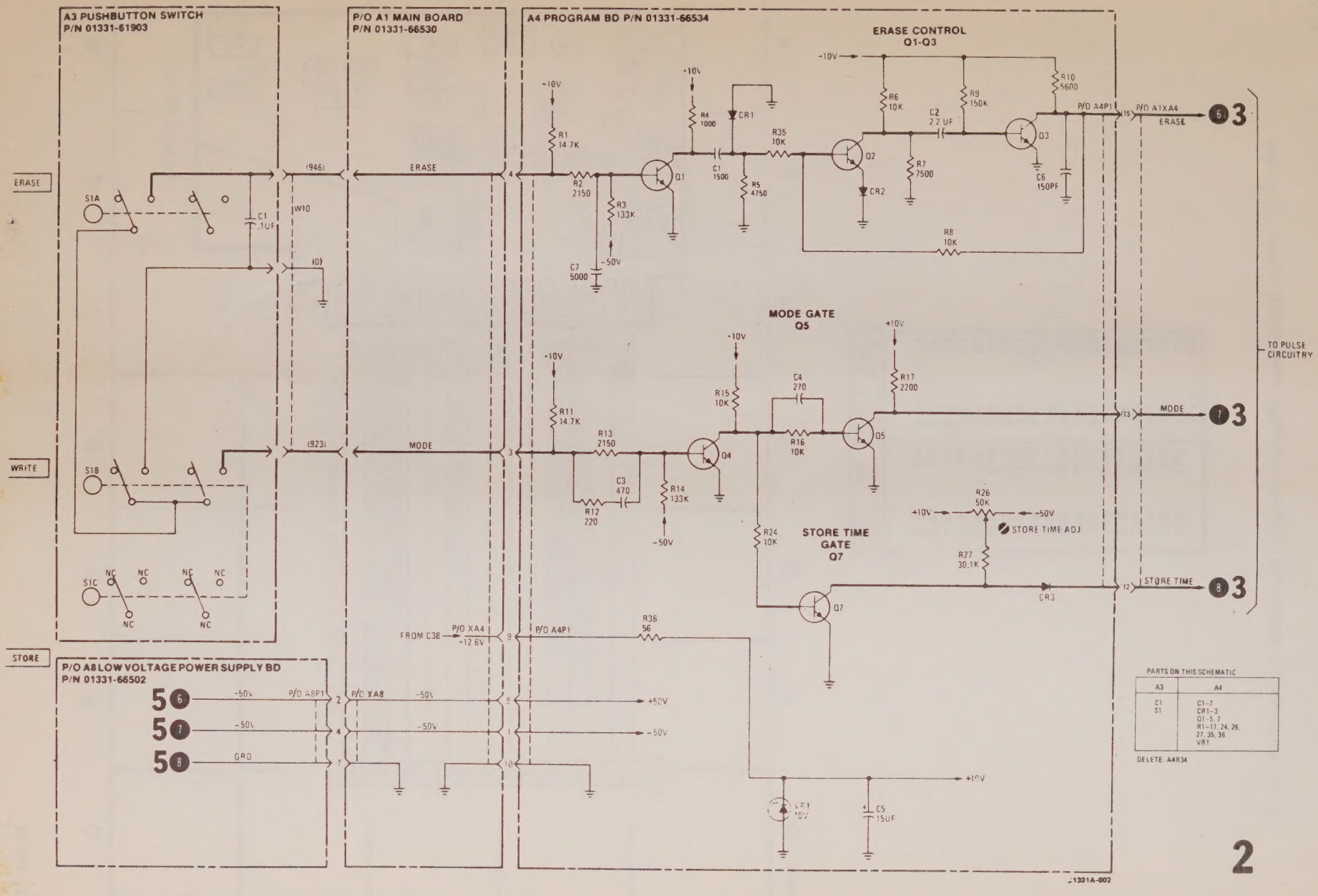


Figure 8-7.
Service Information - Program Circuits - Assemblies A3, A4 (sheet 2 of 2)

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